WATER WORKS AND SEWERAGE

August, 1934 — Editor — Vol. LXXXI. No. 8

Water Softening Plant of Lancaster, Ohio. Newest of Zeolite Softening Plants Serving Municipalities, Walter W. Graf, City Engineer; Charles P. Hoover, Consulting Engineer.

IN THIS ISSUE

Increasing the Salability of Sludge
Evaluating Cost of Sludge Disposal Methods
Recent Developments in Municipal Water Softening
Algae Growth Raises pH of Water at Coatesville, Pa.
Meetings of Pennsylvania Water Works Operators Association, Pennsylvania Sewage Works Association, American Water Works Association (continued), and California Sewage Works Association

DEARBORN *Reports*

on Treatment of Normal Raw Sewage Alone

Suspended Solids Removal	B. O. D. Reduction	Percentage D. O. Saturation
92%	85%	45%

by Laughlin Chemical-Mechanical Process

FOR upwards of two years engineers and municipal officials have been watching Dearborn's West Side plant. ¶They have been asking whether Dearborn's new Chemical-Mechanical treatment of sewage, including liquid wastes from steel and motor plants, would accomplish what no other known system could handle so successfully. ¶Now—Mr. Mark B. Owen, Dearborn's Superintendent of Public Works, tells the story—a story that will win the interest of every engineer, municipal official and student of public economy. ¶At the right we give you the highlight results of the first two years' operation. Mr. Owen's report concludes:

"The results obtained and the cost of operation during the first two years have not only been satisfactory but highly pleasing to the officials of the City of Dearborn. The quality of effluent produced has exceeded that expected two years ago. The cost of operating has been within the estimated amount when the plant was ordered built."

TWO years of operation showed a sewage treatment and sludge disposal, composite volume 1424 million gallons (1294 million of domestic sewage, 130 million sludge from sedimentation plant handling 16 m.g.d. of sewage).

•

17,792 tons, 60 to 65% moisture, vacuum filter cake disposed of satisfactorily without nuisance. Sludge dewatered on vacuum filters with continually improving results per square foot of filter area during the period.

•

Total cost of operation, maintenance, treatment of sewage and disposal of sludge for two years, was $77,785.

•

Plant capacities: Sewage pumping 75 m.g.d. Sludge disposal and chemical feeding equipment 40 m.g.d. Laughlin Clarifiers 8 m.g.d.

•

Well clarified effluent discharged at pH 7.8, practically free from organic settleable and suspended solids.

•

Architecture in keeping with that of Ford's early American village.

•

In the last six months of this operating period one Laughlin Magnetite Clarifier treated 1.74 m.g.d. of raw sewage alone. DURING THIS TIME AN EIGHTY-FIVE DAY RUN UNDER CONDITIONS MORE TYPICAL OF OTHER INSTALLATIONS, GAVE AN AVERAGE B.O.D. IN THE EFFLUENT OF 20 p.p.m.—A REDUCTION OF 85%.

Bear in mind that these results were achieved in a plant not designed to secure such a high degree of treatment. Performance far exceeded fair expectation, and strikingly emphasizes the flexibility of the general methods employed.

Whether or not you have read Mr. Owen's report "TWO YEARS OPERATING EXPERIENCE OF MODERN CHEMICAL-MECHANICAL SEWAGE TREATMENT, DEARBORN, MICHIGAN" in July Sewage Works Journal, you will undoubtedly welcome a reprint of this article in convenient booklet form. ¶If a copy hasn't reached you by the time this advertisement appears, write us and we'll see that it goes to you promptly.

FILTRATION EQUIPMENT CORPORATION

Division of AMERICAN CYANAMID COMPANY

Sales Office: 350 Madison Avenue New York

WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues

J. R. Rumsey, Superintendent, Sewage Treatment Works, Grand Rapids, Mich., will report on experiences with power production during the past year by use of gas engines operated on sludge gas at the Grand Rapids plant. Costs and performance are carefully analyzed.

J. E. Herring, Superintendent of Meters, Jacksonville,, (Fla.) will tell of methods employed in the operation of Jacksonville's Meter Department: describe field and shop practices of maintenance, testing and repairing.

Dr. W. Rudolfs, Chief of Water and Sewage Research, New Jersey Agricultural Experimental Station, Rutgers, N. J., will report on basic studies of the mechanics of the activated sludge process—including the effect of varying degrees of chlorination.

Herman Forster, Deputy Commissioner of Water, New York City, will discuss the "Recreational Usage of Reservoirs" and the Department of Water Supply's system of sanitation control and procedures followed in regulating recreational usage of its reservoirs and lands bordering on them.

Professor E. F. Stover, University of Pennsylvania, will describe "A New Type of Rate Controller," designed and developed in the laboratory under his supervision and now in practical use at a filtration plant. Laboratory tests supported by practical operating data reveal the improved characteristics of this novel filter rate controller.

C. E. Keefer, Engineer of Sewage Treatment, Baltimore, Md., will compare actual costs of sludge, dewatering operations at Baltimore with the ordinary vacuum filtration scheme tried and the greater economy of the sludge elutriation-filtration process recently developed at Baltimore.

R. F. Goudey, Chief Sanitary Engineer, Department Water Supply, Los Angeles, Calif., will tell of modern and improved methods applied in safeguarding and purifying the Los Angeles' supply.

Richard Gould, Chief Engineer, Department of Sanitation, New York City, will describe New York City's 50 million gallon sewage tratment project under way, which involves chemical precipitation.

John A. Carollo, Phoenix, Ariz., will describe a simplified method of determining "Deterioration and Loss of Carrying Capacity of Water Mains" without interruption of service or costly preparation. L. R. Burch, Tucson, Ariz., in a companion article, tells of the method used by the Tucson Water Department and with what results.

John R. Downes, Superintendent, Sewage Treatment Works, Plainfield, N. J., will report the results procured and cost of partial chemical precipitation, to reduce the loading on the biological secondary treatment at the Plainfield works. A second article by Mr. Downes will cover operating data and costs of sludge dewatering by the centrifugal spray-drying process recently installed at the Plainfield plant.

Vol. LXXXI, No. 8

CONTENTS for AUGUST 1934

Recent Developments in Municipal Water Softening 263
By A. S. BEHRMAN
Chemical Director, International Filter Co., Chicago

Evaluating the Costs of Sludge Disposal Methods 268
A Symposium by
HARRY F. FERGUSON, W. HOMER WISELY, SAMUEL A. GREELY and C. R. VELZEY

Algae Growth Raises pH of Water 275
By WILLIAM C. EMIGH
City Engineer, Coatesville, Pa.

Increasing the Salability of Sludge 277
By P. N. DANIELS, C. E.
Superintendent of Sewage Treatment Works, Trenton, N. J.

Meeting of the California Sewage Works Association 280

Conference of the Pennsylvania Water Works Operators' Association 283

Eighth Annual Conference of the Pennsylvania Sewage Works Association 288

A Digest of Papers Presented Before the 54th A. W. W. A. Convention (Continued from the July Issue) 290

Editorials 294

New Equipment and Literature 295

Published monthly by the GILLETTE PUBLISHING CO., Daily News Building, Chicago, Ill.

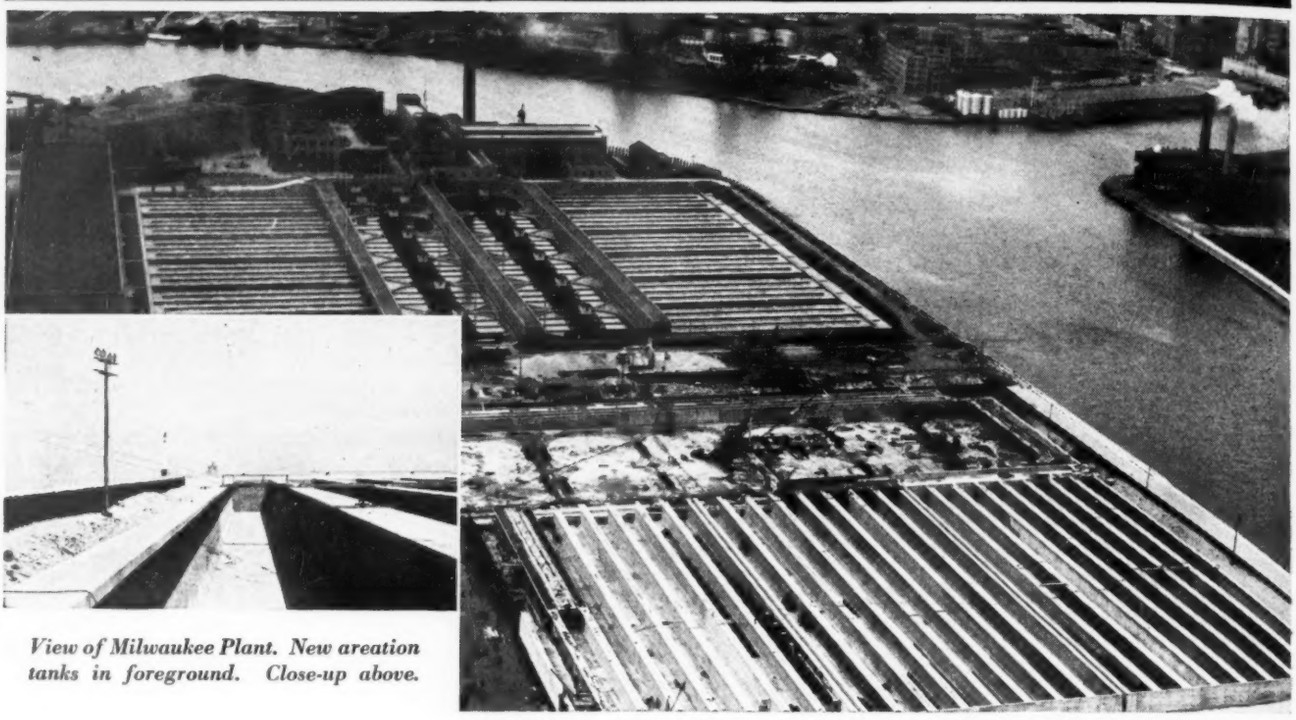
Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Published monthly at 400 W. Madison Street, Chicago, Ill. Per copy 25c. Subscription rates $2.00 per year. Canadian and Foreign, $3.00 per year. Copyright, 1934, by Gillette Publishing Company, Publishers of: Water Works and Sewerage, Roads and Streets, Oil and Soap, The Art of Mosaics and Terrazzo, Road and Street Catalog and Data Book, Water Works Catalog and Data Book.

HALBERT P. GILLETTE, Pres. and Editor in Chief; E. S. GILLETTE, Vice-Pres. and Secretary; E. C. KELLY, Vice-President; J. M. ANGELL, JR., Eastern Manager; L. H. ENSLOW, 420 Lexington Ave., New York, N. Y., Editor; C. T. MURRAY, Managing Editor; JOHN R. BAYLIS, Associate Editor; D. G. LEDGERWOOD, Make-Up Editor.

Chicago Office, Daily News Building. Cleveland Office, 2100 Keith Building. New York Office, 420 Lexington Avenue. San Francisco Office, 155 Montgomery Street.

Addresses will be changed as frequently as desired, upon notification; not otherwise. Changes of address should be sent in at least two weeks before the date of the next issue of *Water Works and Sewerage*, in order for them to be effective for that number. Immediate notice should be given of any delay in the receipt of the magazine.

13,500
ALOXITE BRAND DIFFUSER PLATES
selected for Milwaukee's
Sewage Treatment Plant Extension



View of Milwaukee Plant. New areation tanks in foreground. Close-up above.

Photo, Courtesy Milwaukee Journal

A further evidence of the ability of these diffusers to meet the most exacting specifications for:

PERMEABILITY...UNIFORMITY...PRESSURE LOSS... STRENGTH...DIMENSIONS AND SHAPE...INERTNESS

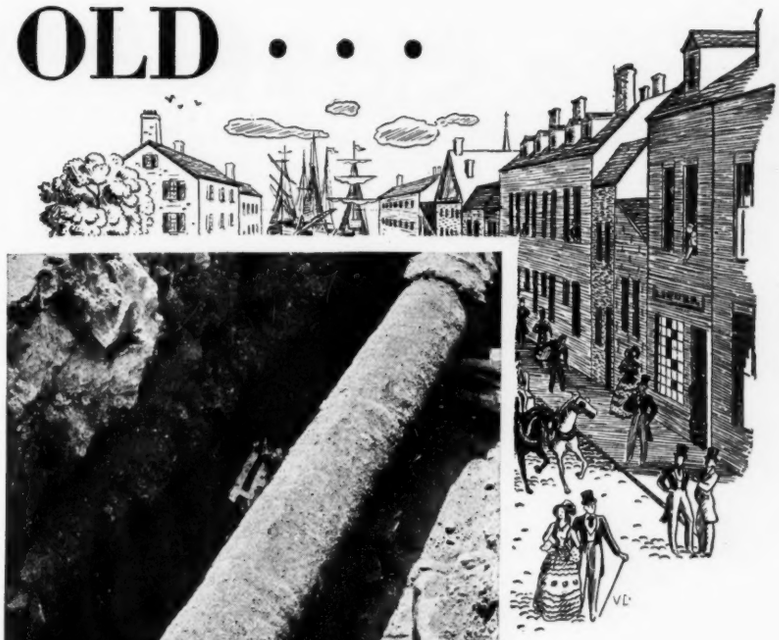
ENGINEERS of the Sewerage Commission of the City of Milwaukee and all engineers throughout the country recognize the importance of choosing none but the best product for the important function of air diffusion—the heart of the plant—where they "make or break" plant efficiency. To insure proper selection of diffusers for your project, utilize the services of our Sanitary and Filtration Department—directed by trained Sanitary Engineers.

THE CARBORUNDUM CO., NIAGARA FALLS, N. Y.

CANADIAN CARBORUNDUM CO., LTD., NIAGARA FALLS, ONT.

(CARBORUNDUM AND ALOXITE ARE REGISTERED TRADE-MARKS OF THE CARBORUNDUM COMPANY)

93 YEARS OLD . . .



and still good for more years of service

This is the way New York looked in 1841 when the cast iron pipe shown at left was installed. It is still in use and good for more service.

THE CAST IRON PIPE shown in the above unretouched photograph is part of a water main installed in the city of New York in 1841. Recently it was exposed to the light of day for the first time in 93 years when a construction crew removed a section of the pipe to cut in a valve. On inspection the removed section of pipe proved to be in excellent condition indicating that this old cast iron main will continue to serve New York's taxpayers, and save them money, for many years to come.

Cast iron mains still in use after serving 100 to 200 years, and longer, were recently uncovered and inspected in England, France, Germany and the United States. All were in satisfactory condition for further service. Thus, evidence accumulates to prove that the useful life of cast iron pipe is *more than a century.*

The reason for the long life and low maintenance cost of cast iron pipe is its effective resistance to rust. Cast iron is the one ferrous metal for water and gas mains, and for sewer construction, that will not disintegrate from rust. This characteristic makes cast iron pipe the most practicable for underground mains since rust will not destroy it.

For further information, address The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 309 Peoples Gas Building, Chicago, Illinois.

Methods of evaluating bids now in use by engineers rate the life of cast iron pipe at 100 years minimum

CAST IRON PIPE

Look for this *trade-mark*

Please mention WATER WORKS AND SEWERAGE—it helps.

Life's Cheapest Necessities

AIR——WATER

Water is not quite as "cheap as the air we breathe", but statistics show the average per capita cost in this country is $4.00 per year, based on an average consumption of 32,850 gallons (about 6c per family daily).

Unlike air, water retains impurities, tastes, odors, etc., in such harmful concentrations that purification is essential and required by State and Federal legislation.

4c* per person, per year, pays the cost of removing tastes and odors thru the use of AQUA NUCHAR

CAN YOU AFFORD to be without this insurance, which costs so little and does so much—eliminates your complaints, and helps to build up the prestige of your municipality thru excellent drinking water?

POWDERED ACTIVATED AQUA NUCHAR CARBON

INDUSTRIAL CHEMICAL SALES COMPANY, INC.

230 Park Avenue, New York 205 W. Wacker Drive, Chicago

* Abstracted from report of A.W.W.A. Committee on Control of Tastes and Odors and contained in our booklet, "Taste and Odor Control".

Every Water Works Man

can use this tested method of treatment

Send coupon for your FREE copy. Gives specific operating data on pipe line sterilization

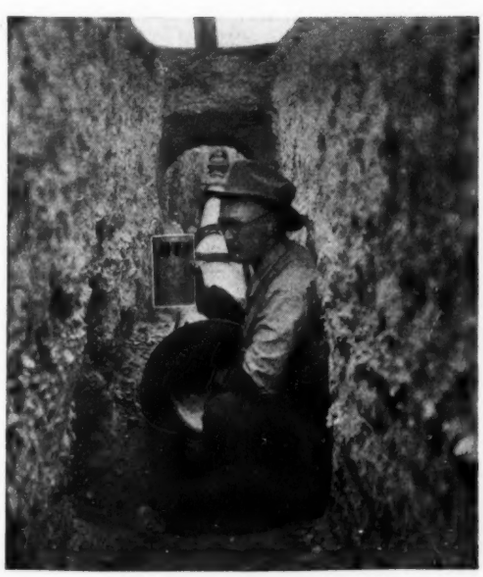
THE folder pictured at the left contains simple, concise instructions on how to insure a clean bill of health for new pipe lines.

Tells how to chlorinate them easily, quickly and economically with HTH—the method that is now practically standard on all new construction and repair work.

Handy reference table shows proper HTH dosages for various pipe diameters and the proper intervals for placing these dosages. Every engineer, superintendent, and construction foreman should read this folder and keep it handy. Fill out the coupon now, send it to us and your copy will be forwarded free of charge by return mail.

The MATHIESON ALKALI WORKS (*Inc.*)
250 Park Avenue New York, N. Y.

Soda Ash . . . Caustic Soda . . . Bicarbonate of Soda . . . Liquid Chlorine . . . Bleaching Powder . . . HTH and HTH-15 . . . Ammonia, Anhydrous and Aqua . . . PH-Plus (Fused Alkali) . . . Solid Carbon Dioxide . . . CCH (Industrial Hypochlorite)



NEW WATER MAIN AT EL PASO STERILIZED WITH HTH

The picture at the left shows a dosage of HTH being placed in a water main under construction at El Paso, Texas. HTH was also used in sterilizing El Paso's new 40,000,000-gallon concrete-covered reservoir. F. M. Murphy, acting superintendent, writes: "The cleaning and preparing of this large tank was no small undertaking . . . the 20 inch feed main, approximately one mile long, was cleansed as laid by the use of HTH and allowed to stand several days. Floors and side walls were treated by the same method. The tank has now been in use nearly two months (July 15, 1933) and has shown no bacteria count."

• • •

HTH is a dry, free-flowing chlorine carrier. More than 65% of its weight is chlorine available for killing bacteria and destroying odors. Retains its strength during long periods of storage, even under summer weather conditions. No special equipment needed. No returnable containers. Shipped in cases of one dozen 4-lb. cans and in boxes of two 40-lb. cans.

The Mathieson Alkali Works *(Inc.)*
250 Park Avenue, New York.

I want your folder, "Sterilizing New Water Mains." Please send it to me at the address below.

Name.....

Company.....

Address.....

AN ANSWER TO THE QUESTION:
"WHAT IS THE MEANING OF pH?"

pH *And Its* Practical Application

By *Frank L. LaMotte*
William R. Kenny
Allen B. Reed

Table of Contents

Section A. MECHANISM OF HYDROGEN ION DETERMINATIONS

I—Introduction and Preliminary Discussion
II—Hydrogen and Hydroxyl Ions
III—Buffer Action
IV—Determination of pH
V—Sources of Error

Section B. PRACTICAL APPLICATION OF HYDROGEN ION DETERMINATIONS IN INDUSTRY AND SCIENCE

VI—Municipal and Industrial Water Supply
VII—Water Corrosion Problems
VIII—Disposal of Sewage and Industrial Waste
IX—Sugar Industry
X—Gelatin and Glue
XI—Leather Manufacture
XII—Textile Industry
XIII—Pulp and Paper Industry
XIV—Food Industries
XV—Cleaning Processes
XVI—Electrodeposition of Metals
XVII—General Industrial Chemistry
XVIII—Bacteriology, Pathology, and Titration Procedures
XIX—Soils

$3.50

Cloth bound, 6x9, 255 Pages, Original Control Charts, Illustrated, Indexed.

The charts alone are well worth the price of this book.

TODAY the term "pH" is part of the routine vocabulary of almost every technical man, and the usefulness of the subject has benefited so many processes that it is now an accepted operating factor. So rapid has been its adoption throughout the technical world, that a great many routine workers now using some means of pH control do not have a clear understanding of the term "pH" itself, nor of the simple underlying principles involved in its measurement.

It is the purpose of this book to supply the need for such fundamental information in simple language, avoiding technical terms as much as possible.

Scientific men whose early training has not included this phase of chemistry and operating men will find "pH And Its Practical Application" to be a *practical* book for any reader who is not particularly interested in the theoretical aspects of hydrogen in concentration.

The broad scope of the book is indicated by the Table of Contents.

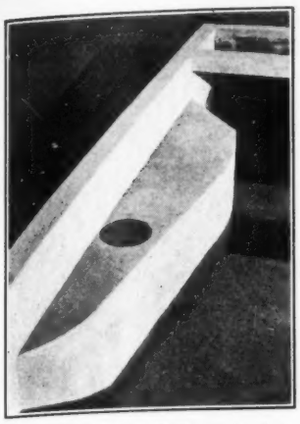
GILLETTE BOOK COMPANY
400 W. Madison Street
CHICAGO, ILLINOIS

------ USE THIS COUPON ----------

Name .....
Position .....
Company .....
Address .....
City ..... State .....
WW & 8-8-34

GILLETTE BOOK COMPANY,
400 W. Madison St., Chicago, Ill.

I should like to have "pH And Its Practical Application" on 10 days' free trial At the end of that time I will remit $3.50 or return the book, postpaid.



Side view of Parshall Flume showing contour.

View of Parshall Flume showing actual flow conditions.

120,000,000 Gallons per Day of Sewage Effluent measured through a Parshall Flume at Providence

Water Works and Sewerage Engineers alike are studying with interest the Parshall Flume* which is operating so successfully at the Providence Sewage Disposal Plant as it is the first large installation of such a measuring device in either of these fields.

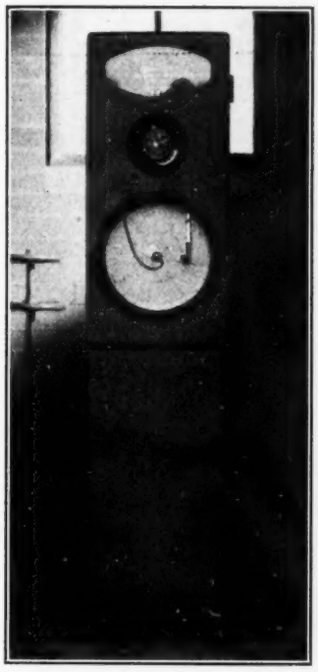
Builders Iron Foundry collaborated in the design of the Flume and adapted a Type Y Register-Indicator-Recorder for use with it. Besides furnishing complete flow readings near the Flume a Selsyn Transmitter attachment actuates a Rate-of-Flow Indicator in the distant chemical laboratory.

This is just another example of Builders pioneering in the problems of flow measurement. What's your problem (whether it is usual or unusual, small or large)?

*FREE—An illustrated reprint of an N. E. W. W. A. Paper describing this installation and showing the results of tests for accuracy will be mailed upon request.

VENTURI

"VENTURI"-Registered



Type Y Register-Indicator-Recorder adapted for use with Parshall Flume.

BUILDERS IRON FOUNDRY - - - PROVIDENCE, R. I.

LFC

9½ MILES MORE OF *"Lynchburg" High Tensile*

Only 8 miles more and the City of Lynchburg's 21-mile Wooden Stave Pipe Line will be entirely replaced with "Lynchburg" 36-inch High Tensile Cast Iron Pipe—An installation to which both the City of Lynchburg and the Lynchburg Foundry point with pride . . Perfect castings—and every piece delivered on time . . . This is typical "Lynchburg Service" . . . Write, Wire, or Phone "Lynchburg" for quick estimates.

Bell and Spigot Pipe and Fittings. From 4" to 54".
Cast Iron Flanged Pipe. From 3" to 84".
Cast Iron Flanged Fittings and Flanges. From 1" to 84".
Super-de Lavaud Centrifugal Cast Iron Pipe.

Special Iron Castings for the Chemical Industry

LYNCHBURG FOUNDRY COMPANY

Peoples Gas Building Chicago, Ill. — GENERAL OFFICE - LYNCHBURG, VIRGINIA — Empire State Building New York, N. Y.

9 times the 50 lb. hammer drops from the highest level

and still the pipe resists failure

• Higher and higher goes the 50-pound hammer to levels unapproached in impact tests with centrifugal pipe as we formerly made it. Technical press representatives recently saw Super-de Lavaud Pipe successfully withstand 9 drops of the hammer from the maximum height of 5 feet. Average results of hundreds of less rigorous though standard tests prove that the impact resistance of Super-de Lavaud Pipe is more than doubled. This extraordinary increase in ability to resist shock is due to a basic metallurgical change in gray iron "cast without chill in a metal mold" by the patented Super-de Lavaud process. Super-de Lavaud Pipe does not shatter at bursting pressure. Send for descriptive booklet.

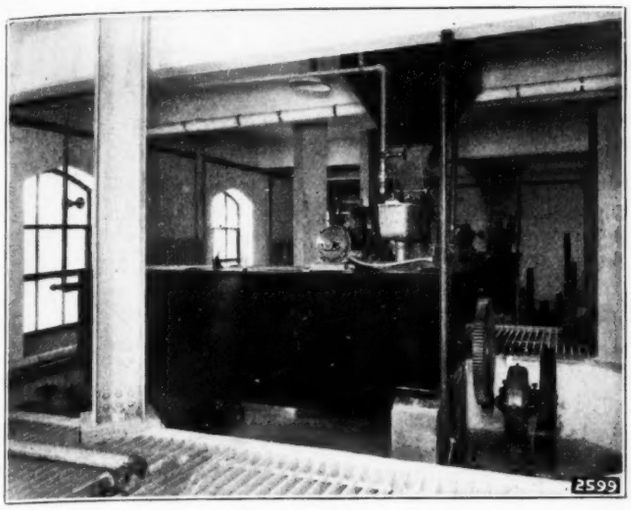
UNITED STATES PIPE AND FOUNDRY CO.
BURLINGTON • NEW JERSEY
Foundries and Sales Offices throughout the United States

Testing 8" class 150 Super-de Lavaud Pipe for impact resistance.

U.S. SUPER-DE LAVAUD PIPE
IMPACT RESISTANCE INCREASED MORE THAN 100%

WATER WORKS AND SEWERAGE
A GILLETTE PUBLICATION
VOL. LXXXI AUGUST, 1934 No. 8

Modern Continuous Lime Slaker and Feeder at the Cedar Rapids, Iowa, Softening Plant.



RECENT DEVELOPMENTS IN MUNICIPAL WATER SOFTENING

By A. S. BEHRMAN
Chemical Director, International Filter Co., Chicago

IT IS now almost a century since the lime-soda process of water softening was invented. It is only within the last twenty years, however, that the process has come into use to any considerable extent for municipal water softening.

The principal reason for this greatly delayed progress was "after-precipitation"—that annoying and expensive deposition of calcium carbonate and magnesium hydroxide in distribution mains, house lines, water meters, hot water heaters and other services.

In lime-soda softening, the calcium of the hard water is precipitated as calcium carbonate, the magnesium as magnesium hydroxide. Unfortunately, however, the chemical reactions involved in the process do not go to their theoretical limits of completion, particularly in cold process softening. As a result, the softened water contains an amount of calcium carbonate and magnesium hydroxide in excess of the theoretical solubilities of these substances. The excess, present in colloidal or supersaturated condition, tends to deposit out slowly on any surface with which the water comes in contact—hence the term "after-precipitation."

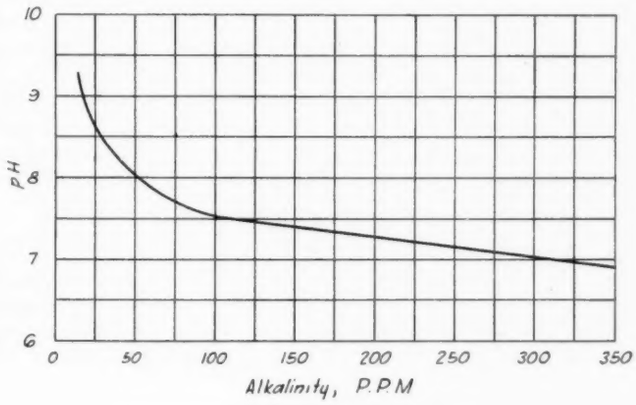
Prevention of After-Precipitation

Following the practice adopted in industrial water softening, one of the first attempts to improve municipal softening performance and to minimize after-precipitation was the use of a coagulant, such as aluminum sulfate or ferrous sulfate; but the use of coagulants proved inadequate.

The real answer to the problem of after-precipitation was found in recarbonation. This process consists simply in adding carbon dioxide gas (generated from any convenient fuel) in proper amount to the softened water, usually before filtration.

Since the solubility of calcium carbonate is now known to be a function of pH, the amount of carbon dioxide gas diffused into the water is just sufficient to reduce the pH to, or slightly above, the point corresponding to the solubility equilibrium of calcium carbonate—usually just above this point, in order to permit the deposition of a thin film of the carbonate on mains and other metal surfaces and so prevent oxygen corrosion. The relationship between pH and calcium carbonate alkalinity is well shown in the following curve developed by Baylis[1]:

To my mind, recarbonation is by far the most important improvement in municipal lime-soda water



Curve Showing the Relationship Between Calcium Carbonate in Solution (Alkalinity) and pH Values.

softening that has been made since Clark originated his process; and great credit must be given C. P. Hoover of Columbus, O., for the popularization of recarbonation practice.

A multitude of improvements have been suggested for the lime-soda process in the past fifteen or twenty years—improvements both chemical and mechanical. Among the chemical contributions we have already mentioned the use of coagulants. The most notable newcomers in this field are sodium aluminate—unique in being an alkaline coagulant—and the ferric salts: ferric chloride, ferric sulfate and "chlorinated copperas."

"Split treatment" has also been advocated by Hoover[2] in some cases, as well as excess lime and double recarbonation in others. Using the latter method of treatment, it has been reported in some cases that residual alkalinites (hardness) very close to the theoretical solubilities of magnesium hydrate and calcium carbonate have been obtained.

While these last-named chemical improvements are of great interest and importance, more experience and operating data under a variety of local conditions will probably be required before the extent of their general adoption can accurately be predicted.

It is worth bearing in mind that many hundreds of modern industrial lime-soda softening plants have for many years been delivering softened water quite comparable chemically to the best product of municipal softening plants, except for freedom from after-precipitation, which is not a serious consideration in industrial plants. The only chemical aid used in these plants is an effective dosage of coagulant. While the amount of coagulant required to accomplish the desired result would entail an appreciable expense in a municipal plant handling very large volumes of water, it would seem that smaller community plants, at least, could well give more serious consideration to the advantages and simplicity in operation to be gained from employing an adequate dosage of coagulant.

Numerous Mechanical Improvements Introduced in Lime-Soda Softening

Several very interesting advances have also been made in what we might term the physical aspects of municipal lime-soda softening. Starting with the entrance of the water into the softening plant, we see new types of aerators for removing free carbon dioxide and for oxidizing and precipitating iron; a continuous and automatic lime slaker, which makes possible the efficient use of quicklime instead of the more expensive hydrated lime, and the advantage of the elimination of the dust nuisance inherent in the latter; new types of mixers for first rapidly distributing the chemical reagents with the water being treated, and other types for subsequently forming a floc or precipitate of improved settling qualities; clarifiers for the continuous removal of sludge; and improved types of filters and filter control equipment. The return of previously precipitated sludge to accelerate the softening reaction is another physical development with possibilities that have not yet been exhausted.

Taking the risk that a self-appointed prophet always invites, I believe that the greatest opportunity for improvement in large scale lime-soda softening in the future will be found in the physical and mechanical aspects of the process, rather than in important variations of chemical treatment.

Municipal Zeolite Softening vs. Lime Soda Softening

Let us pass now to a brief examination of what is probably the most striking innovation in municipal water softening in the last ten or twelve years—that is, the application of zeolite softening to community water supplies.

The history of zeolite softening in the United States has been one of extremely rapid development. Unfortunately, however, it has been marred by almost incessant patent litigation and by such highly controversial discussion and such industrious propaganda that considerable confusion has resulted in the mind of the lay observer.

It is not the purpose of this paper to attempt to settle these controversies. The only duty which can properly be assumed is to analyze the history of the municipal zeolite softening plants—about thirty in number—which have been built in the past ten years, and to indulge in certain generalizatoins and predictions based upon this analysis.

Probably the most satisfactory way of approaching this task will be to list the most important conclusions to which experience appears to have given general acceptance. It will be necessary, in the nature of the case, to include certain generalizations bearing on the relative desirabiliy of the lime-soda and zeolite softening processes under the conditions indicated.

1. It is not usually desirable to supply a community with water of "zero hardness." It is generally agreed that it is not justifiable, on economic grounds, to soften water to be used for general community purposes below a hardness of from 4 to 6 grains per gallon (68 to 103 parts per million). Furthermore, it is finally coming to be realized that to completely soften water is to invite oxygen corrosion of distribution systems. If the "zero hardness" effluent from the zeolite softeners is mixed with enough of the hard raw water to bring the resultant hardness to within the range of 4 to 6 grains per gallon previously mentioned, this admixture will quite frequently satisfy the requirements with respect to saturation with calcium carbonate necessary for the protecting of pipe surfaces. If not, the pH may be adjusted chemically to bring about the proper equilibrium conditions.

2. It is not now considered good practice to attempt to remove considerable amounts of dissolved iron from water by zeolites. Numerous investigations, including our own, have shown that ferrous iron can be removed by true base exchange both by greensand and by the better types of synthetic zeolites. A series of field investigations made by this company several years ago, however, showed that in actual practice it is almost impossible to maintain the absolutely closed and oxygen-free system necessary to maintain the iron in the ferrous condition. In consequence, part of the iron is oxidized and precipitated before it reaches the zeolite bed and this will in time foul the bed and possibly even the underdrain system. It is really remarkable, however, how little the base exchange capacity of the better grades of greensand and synthetic zeolites is affected even when completely coated with deposited iron salts. We have examined samples of greensand and of our own synthetic zeolites so red-brown with ferric hydroxide as to be almost unrecognizable; yet the exchange capacity in all cases was within 10 per cent of the original value.

The best practice in zeolite softening of waters containing considerable quantities of iron is to first remove the iron by aeration and filtration. An inci-

dental but extremely important advantage of the aeration is to raise the pH of the water by displacing much of its free carbon dioxide content, thus making it easier to assure freedom from corrosion of the distribution system or damage to the zeolite bed.

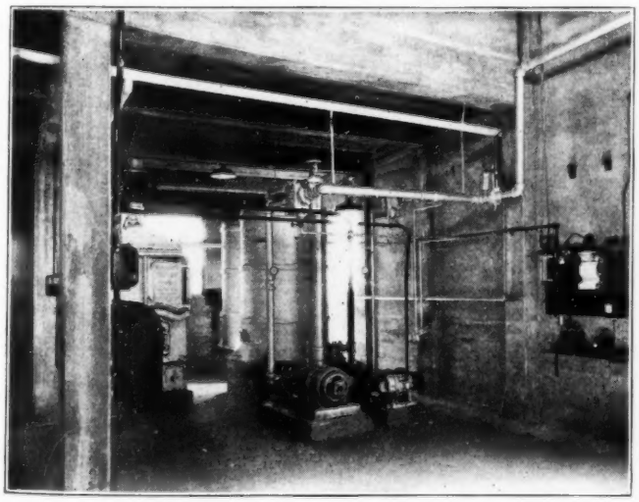
3. A quite turbid water should be softened by the lime-soda process, since relatively little extra equipment is required to make the usual filtration plant serve as a softening plant also. Accordingly, we may expect to see a predominance of lime-soda softening plants in large municipal installations, regardless of any other considerations. This prediction is based on the fact that the majority of large communities depend on surface water supplies which require clarification in any case.

4. The analysis of a water has an important bearing on the choice between lime-soda and zeolite softening. Lime for removing bicarbonate hardness costs only about half as much as does the salt required for regeneration of zeolites; whereas, the soda-ash required for removing non-carbonate hardness costs approximately 25 per cent more than does the necessary salt for removing the same hardness.

Waters which are even excessively hard may be softened with a fair degree of satisfaction by the modern high capacity zeolites; but in case of such waters containing excessive quantities of sodium salts also, the volume of soft water delivered by a given volume of zeolite frequently makes the process unprofitable. In such cases the lime-soda process is generally preferable.

5. Engineering and other local considerations may operate in favor of zeolite softening even though the lime-soda process is logically indicated otherwise. The commonest of these factors is its adaptation to the pumping system already available, especially in small communities. Another consideration in some cases is the lack of suitable facilities for the disposal of the sludge from the lime-soda precipitation. Still a third is the fact that a zeolite softening plant is simpler to operate than a lime-soda plant, although there is a growing appreciation of the fact that the operation of a zeolite plant is far from fool-proof. The principal distinction seems to be that the improper operation of the lime-soda plant will be noticed more readily by the consumer than will the inefficient conduct of a zeolite plant. Further, the zeolite plant can be made to operate almost if not wholly automatically.

In spite of its inherent chemical limitations, it is safe to predict that zeolite softening for municipalities will steadily increase—probably more so in the actual number of installations than lime-soda softening, if only for the reason that there are a greater number of small communities where engineering considerations are likely to favor the zeolite process than there are large communities which can profitably or advantageously utilize the lime-soda process.



Recarbonating Units and CO_2 Recorder at the Fargo, North Dakota, Water Softening Plant.

The large majority of the municipal zeolite softening plants in the United States have thus far used greensand as the softening medium. The proportion, however, employing modern high capacity gel-zeolites is steadily increasing and, in our opinion, will continue to increase as the possibilities of these newer and improved materials are more fully realized. The basis for this opinion will become clearer on an analysis of the cost of softening water by the two types of zeolites.

The Cost of Zeolite Water Softening

The cost of zeolite softening may properly be divided into three parts: (1) Initial cost of installation; (2) fixed charges; and (3) operating expense.

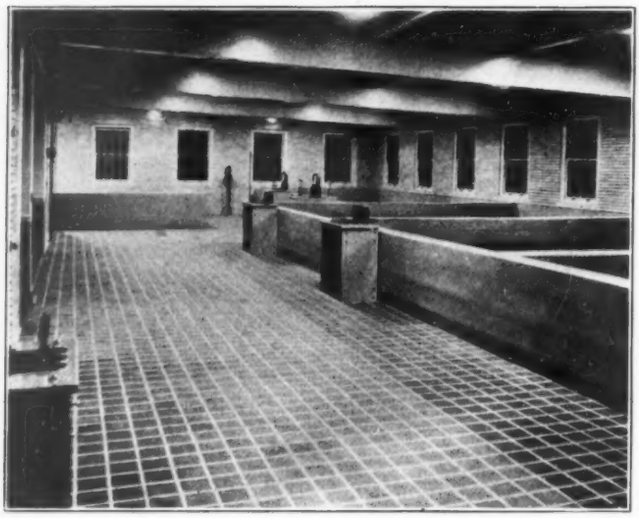
If we take the average softening capacity of greensand as 3,000 grains (of hardness as calcium carbonate) per cubic foot, and that of a good gel-zeolite at from 9,000 to 12,000 grains per cubic foot, it is obvious that the volume of gel-zeolite required to soften a given quantity of water is only a third or fourth of the volume of greensand required for the same softening capacity. The container and other structural requirements for the gel-zeolite bed will therefore be considerably smaller than for the greensand. The amortization of this very appreciable difference thus becomes an item of increased charge against the greensand plant.

The items in the expense of operating a zeolite softener are the salt, water, and labor used in regeneration and the cost of eventually replacing the zeolite.

In the early days of zeolite softening, when enthusiastic salesmen spoke of the "eternal" nature of zeolites, there was a rather natural tendency to regard the original zeolite bed as a capital and permanent investment. Today, however, it is becoming generally recognized that the active life of any zeolite is not at all unlimited; and, that all zeolites, regardless of their nature, will wear out in due course in proportion to the work they have to do—just as truly as any piece of machinery that is in steady service will have to be junked sooner or later, its length of active life depending on the amount of service it is called upon to perform.

Accordingly, there is a growing and wholly intelligent and logical disposition on the part of municipal and industrial operators of zeolite softening plants to consider the cost of the zeolite bed as an operating charge; and this charge, together with the cost of the salt, wash-water and labor required for regeneration, and with the fixed charges, is used in computing the cost per million gallons of softened water.

In selecting the proper zeolite for any particular set of local conditions, the determining factor should therefore be not simply the cost of the original installation, but the cost per million gallons of softened water computed on this basis. Obviously, the proper basis to use for calculating the active life of a zeolite bed, and for amortizing the cost of replacement is not the life of the zeolite in years, but in the millions of gallons of water it will efficiently soften—just as the life of an automobile tire is measured by the miles it travels and not by months or years. By the same token, we may expect to see guarantees of zeolite performance in the future based more and more on the volume of softened water delivered, and on the cost of salt, water and labor required for regeneration, rather than on the guaranteed life of the zeolite in terms of number of years—a guar-



Operating Floor of the Newest Municipal Zeolite Softening Plant, Lancaster, Ohio

antee that may mean much or little depending on the service or idleness of the softening plant within that period.

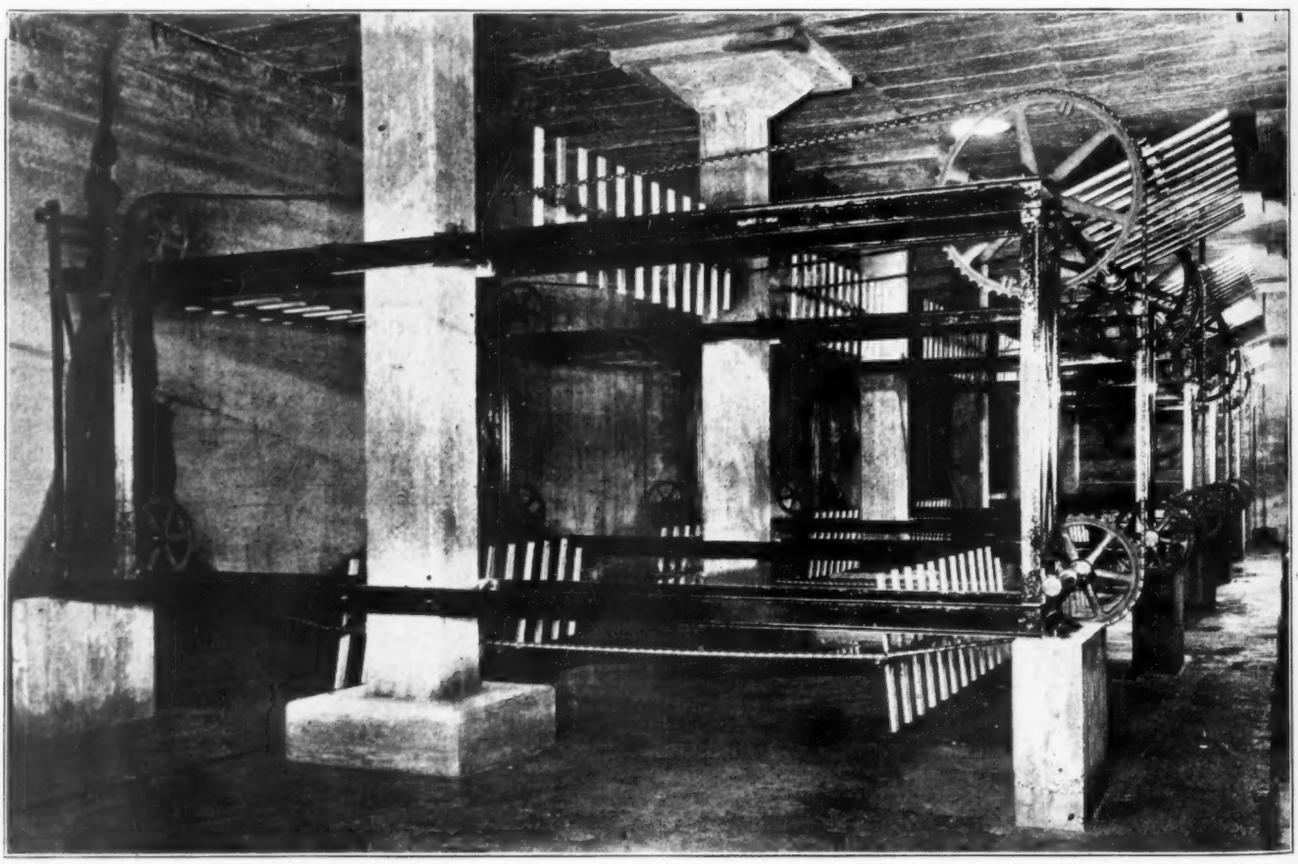
The opportunities for the reduction in operating costs made possible by the use of the most modern high capacity gel-zeolites are just beginning to be appreciated. The most notable economies are in the consumption of salt and wash-water required in regeneration. Whereas 0.5 pound of salt per thousand grains of hardness removed has always been considered the normal requirement for greensand (although very recently there has been a tendency in some quarters to reduce this to 0.45 pound), with a modern efficient gel-zeolite this figure may frequently be reduced to as low as 0.35 or even 0.30 pound per thousand grains.

Important savings in wash water with modern high capacity gel-zeolites accrue from the fact that softener beds of much smaller area may be employed than with greensand. Since the volume of wash water required for regeneration varies almost directly in proportion to the area of the softener bed, it is not surprising that the wash water requirements of an efficient gel-zeolite bed are usually only from one-quarter to one-third of those of a greensand bed of equivalent softening capacity.

In many cases there is also an appreciable saving in labor with the gel-zeolite softening plant, due to the smaller number of regenerations required for a given volume of softened water.

An excellent example of the economies in operation of a modern gel-zeolite plant at Lancaster, Ohio (see front cover of this issue), has recently been described by Hoover.[8] At this plant, supplied with Crystalite manufactured by International Filter Co., the savings in salt and wash-water alone when compared with the operation of an equivalent greensand plant will pay for the Crystalite bed in less than two years. In addition, the high capacity of the Crystalite makes it possible to employ a considerably smaller and less expensive structure, thus appreciably reducing fixed plant charges; while the smaller number of regenerations has brought about a material saving in labor.

This comparison should not be taken to imply that greensand zeolites have no place in water softening practice. On the contrary, there appears to be a very large and definite field in which greensand may well be the logical choice. This field comprises in general the low hardness waters—ranging possibly up to a hardness of about six or seven grains. In the case of the typical



"Super-Mix" for Improving Floc Formation and Precipitation at Minneapolis, Minn. (The direction of water flow is toward the camera. The traveling paddles create eddies as they tend to roll the contents of the chamber.)

hard waters of the central and western sections of this country it seems inevitable, however, that the use of the modern high capacity gel-zeolites will steadily increase, simply because of the great reduction in operating charges which their inherent characteristics make possible. Progress in this direction may be expected as soon as the present unfortunate status of the zeolite industry is corrected sufficiently to permit the chemical and engineering profession to analyze such problems intelligently and without bias.

Finally, there is no doubt that the American public is becoming increasingly cognizant of the desirability of soft water, and of the need for softening plants in hard water districts. Investigations like those of Buswell and Hudson,[4] demonstrating that the installation of a water softening plant is justified by the savings in soap alone, are certain to intensify this general appreciation, and to bring about the eventual installation of municipal water softening plants as soon as funds become available for the purpose.

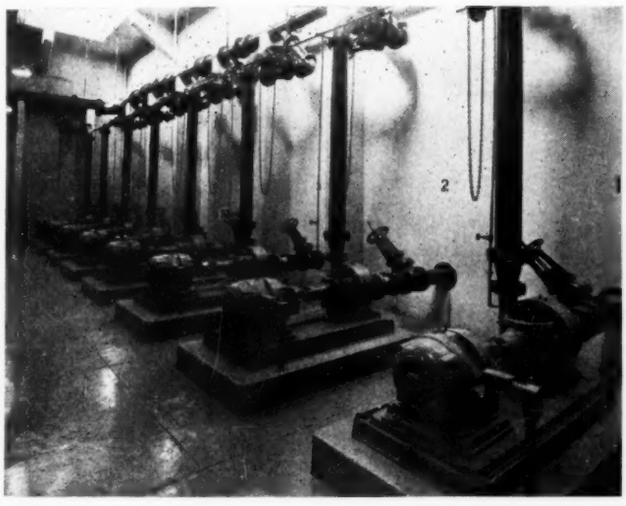
Acknowledgment.—The above article constitutes a condensation and re-write by the author of an unpublished paper presented before the American Chemical Society at Chicago, Ill., September, 1933.

REFERENCES

[1]Baylis: Ind. and Eng. Chem., **19**, p. 777 (July, 1927).
[2]Hoover: Jour. Amer. Waters Assoc., **23**, p. 826 (June, 1931).
[3]Hoover: Public Works, **64**, p. 9 (June, 1933).
[4]Buswell and Hudson: Jour. Amer. Water Works Assoc., **24**, (June, 1932).

▼

Sewage Pump Installation, Wingdale, N. Y.



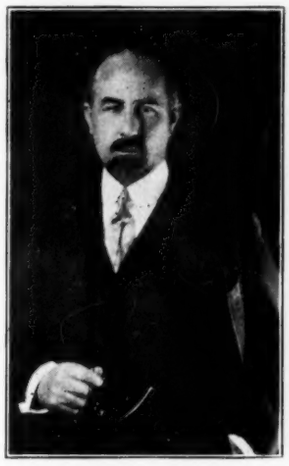
An Interesting Multiple Installation of Sewage Pumps, Harlem Valley State Hospital, Wingdale, N. Y.

This unique pump installation consists of 8 4-inch Gould's Horizontal Bronze Fitted Units driven by Fairbanks-Morse (7.5 H.P.) Squirrel Cage Ball Bearing Motors. Each of the 8 pumps has a capacity of 450 G.P.M. (screened sewage) against a static head of 21 feet. A Multiple Rotary Type Float Switch throws the units into or out of service, in sequence, as the level of sewage in the suction well rises or falls by increments of 6 inches. An Electric Controller and Manufacturing Company's Panel Board makes it possible to have the units operate in any sequence desired, with one unit always left in reserve even at designed peak flows.

The plant was designed by Henry Ryan, Senior Sanitary Engineer, New York State Department of Public Works.

Thirtieth Anniversary of Dorrco Equipment

Mr. Dorr Honored by Associates



John Van Nostrand Dorr, D.Sc.

The 30th anniversary of the first invention of "Dorrco" equipment was celebrated on July 17th at the Westport, Conn., laboratories and experimental plant established some years ago by Mr. Dorr, originally in the picturesque and now famous "Old Westport Mill." One hundred and seventy-five of Mr. Dorr's business associates, friends and employes of the Dorr Company attended the celebration. That same evening he was tendered a testimonial dinner by a group of "Old Timers" in the organization, and friends and business associates of his during his pioneering days.

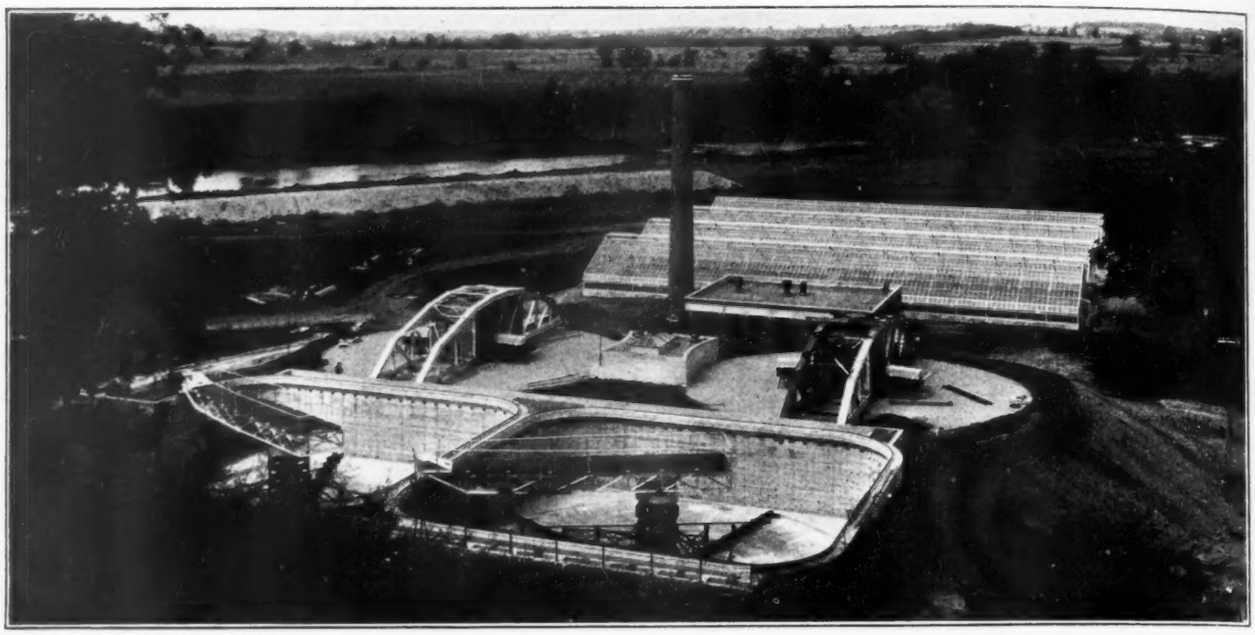
The first Dorr invention (1904) was in the gold mining field and consisted of the "Dorr Classifier" which quickly made him famous in the mining world. Then, two years later (1906), he invented the more widely adaptable "Dorr Continuous Thickener"—which quickly found a place outside of the mining field* and was the forefather of the "Dorr Clarifier" which has been an equally famous invention in the field of water purification and sewage treatment.

In the sanitary field Dorr equipment was introduced by way of a loan, by Mr. Dorr, of one of his "Thickeners" to Langdon Pearse, Sanitary Engineer, Chicago Sanitary District, for experimental trade waste treatment in 1914. In 1916 as the result of field experimentation by E. Lee Peck the "Thickener" design was modified and developed to serve the sanitary field in clarification of liquid waste. It was therefore christened the "Clarifier." In 1920 the Dorr Company established a Sanitary Engineering Department, headed by Frank Bachmann, and pioneered in mechanical sludge handling equipment in the water works and sewerage field.

Starting as a laboratory assistant under Thomas A. Edison, Mr. Dorr is in truth a self-made industrialist of rare acumen and interesting personality—a Doctor of Science, executive, business man, all combined into one "big" man—respected and admired and liked by his many friends, associates and employes. From a one man organization in Denver, Colo., in 1908, to one with offices scattered over the civilized world (some not so civilized) in 26 years, is truly an accomplishment. We, too, would add our congratulations and well wishes to you, Dr. Dorr, on this—the 30th anniversary of your invention.—L. H. E.

*Of interest to our readers: Pennsylvania Salt Manufacturing Co. is on the Dorr records as the first, outside of the ore mining and refining field, to install a "Thickener."—Ed.

RE PUBLIC UTILITY GOVERNMENT CONTRACTS.—The National Recovery Administration on August 4th announced an order exempting public utilities from the requirement that they sign a certificate of code compliance in order to receive a government contract for service such as telephone, electricity, gas, water, etc.



A Modern Separate Digestion Plant with Covered Sludge Beds

EVALUATING THE COSTS OF SLUDGE DISPOSAL METHODS

Dewatering on Vacuum Filters vs. Digestion and Sand Bed Drying

A Symposium Comprising Two Papers Designed to Reveal the Practicability and Comparative Cost of the Two Methods of Sludge Disposal Based on Modern Practices

Part I—The Economics of Sludge Digestion, Dewatering and Disposal

By HARRY F. FERGUSON and W. HOMER WISELY

Respectively, Chief Sanitary Engineer and Assistant Sanitary Engineer, State Department of Public Health, Springfield, Ill.

BECAUSE of the increasing interest in the dewatering of either raw or digested sewage sludge by mechanical filtration with subsequent incineration or other disposal of the dried sludge a question was raised some time ago concerning the actual cost of digesting and dewatering sludge, by present standard methods at existing sewage treatment works using digestion tanks and sand beds. Even though mechanical dewatering, with or without previous digestion of the sludge, is possible from the engineering standpoint it is not practical if the cost is or will be greater than present standard methods. Special cases where sufficient area may not be available for digestion tanks and sand beds are excepted.

To procure authentic cost data it was decided to tabulate and study the actual costs of digesting, drying and disposal of the sludge at six well operated sewage treatment works in the State of Illinois which had different types of units. All, however, were using standard procedure of digestion and sand drying followed by final disposal of the sludge cake as fertilizer or for filling purposes. It was hoped to adjust the cost data for these plants to a common basis and to compare these adjusted costs with the costs of mechanical dewatering presented by S. A. Greeley and C. R. Velzy in the article following this one.

Need for Adjustments to a Common Denominator in Evaulating Costs

The cost of digesting, drying and disposing of sludge at any treatment works is dependent on the solids in the sewage and upon the efficiency of the equipment installed for digestion and drying and for the utilization of gas produced during digestion. Therefore, this information is presented separately for each plant studied (Table 1). The design data shows a wide variation in the available capacities of the digestion, storage and drying units. It was originally planned to adjust these capacities to a common standard unit for digestion and digested-sludge storage tanks and sand drying beds but the statements made by some of the men in charge of the

SUMMARY AND CONCLUSIONS*

Following presentation of the facts and arguments contained in the two papers, which follow, the four authors decided that, based on their analyses and evaluations of the two methods under discussion, the following summarial statement and general conclusions could be subscribed to by them individually and jointly as their findings. To wit:

1. The estimated costs for mechanical filtration of raw or digested sludge, compared to standard digestion and sand drying, indicate that such methods are not economical for plants serving less than 50,000 persons. Further, there is still some doubt concerning plants serving even larger populations.

2. Estimated costs of mechanical filtration of digested sludge are higher than the actual costs of operating sludge drying beds as determined for six Illinois plants. For the larger plants the two types of dewatering approach equality in cost and it is likely that local conditions, such as lack of area or favorable chemical costs or more efficient use of chemicals may make mechanical filtration more economical.

3. Cost estimates of mechanical filtration of raw sludge compare quite favorably for plants serving 100,000 persons or more with the combined digestion and sand drying costs found at the six Illinois plants. However, crude sludge cake can not be readily disposed of because of its character and a complete cost comparison should include further treatment of the sludge by some means such as drying to produce fertilizer or incineration.

4. Further study and experimentation on mechanical dewatering may result in lower costs but on the other hand there seems some possibility, with further study, that the net cost of digestion and sand drying may also be further reduced.

5. It must be remembered that in these comparisons actual costs of digestion and sand drying are being compared with only estimated costs of mechanical filtration. When actual installations of mechanical filters to handle crude or digested sludge are in operation at representative plants much more dependable comparisons can be made.

plants make it inadvisable at this time to select any arbitrary standard unit capacities. If such standard unit capacities had been decided upon it was planned to adjust the installation and operating costs to common units with the hopes that adjusted costs would permit fair comparisons among the different plants and produce reliable average costs for digestion and drying when using present standard methods. Since it has proven impossible, within the time available after we started to prepare this paper, to make the more extensive detailed study necessary (including conferences with the men in charge of the plants and to make the adjustments in the design units and cost figures) it is our plan to continue the studies. If so, a supplemental or second paper will be presented which will not only make possible a fair comparison of adjusted costs but should evolve more scientific capacity units than we are now using and thus help in the design of future sewage treatment works.

For this paper it is necessary, therefore, that the actual costs only be considered even though the unit costs would be changed if some plants were figured as now capable of handling more sludge without additional units. And, the converse—that additions to some of the plant units would be necessary in order to give a balanced plant. The digesters at Rockford and the drying beds at DeKalb and Peoria were the only units reported by those in charge of these plants to be at or near the point of overload. The value of sludge storage tanks (open tanks or an old covered unheated tank, such as at DeKalb) compared to the covered tanks, designed and installed as digestion and gas collection units, is not definite. However, there is no question as to the value of such storage tanks in providing flexibility between the digestion of the sludge and its actual discharge onto drying beds. With the more valuable utilization of gas, such as in a power engine, it may well be that any expenditure for tanks should be for digestors instead of storage tanks which may be considered primarily to be auxiliary or adjunct units to sludge drying beds.

The operation data (Table 1) represents averages for the past year or two and was made use of in computing total and unit costs given in Table 2.

Operating and Fixed Costs

The units of the treatment works upon which the cost figures are based are those units that are used for the handling of the sludge from the time it is deposited in the primary tanks ready to be pumped to the digestion units until its disposal on the waste pile. The excess activated sludge at Springfield and Peoria is discharged to the primary tanks and therefore all of the sludge going to the digestion units at these two plants is taken from the primary tanks; the secondary tank sludge at DeKalb is likewise discharged to the primary tanks; at Aurora, Galesburg and Rockford, there are no secondary tanks. The operation of mechanical sludge collection equipment in primary clarifiers is not included because such equipment is considered as essential to the separation of sewage and solids in the clarifier. Final disposal is assumed when the sludge cake is dumped onto waste piles; because, at none of the plants has it been necessary to make any further expenditure on the sludge after its disposition there.

The fixed charges, represented by interest and depreciation (Table 2), are calculated at 8 per cent. While a considerable proportion of the cost of some of the digestion units comprised mechanical equipment, the equipment is of such character and is used in such a way that it should have a low rate of depreciation. Unit construction costs at the six plants varied somewhat, although not sufficiently to indicate unbalanced bidding. Digestion tanks averaged about 60 cents per cubic foot for the mechanical type and about 40 cents per cubic

*(It is probably too early to accept any conclusions as to the economy and practicability of sludge disposal by the alternate methods, here evaluated, as other than tentative. With the use of multi-stage digestion, gas utilization for power development, the more efficient and less costly conditioning for dewatering on sand beds or by vacuum filtration which is apparently available through elutriation (simple washing) of the sludge prior to chemical conditioning, a re-evaluation may shortly be in order. For the time being, the present conclusions are as the authors find the situation today.—Editor.)

TABLE 1—DIGESTION TANK AND SLUDGE BED DESIGN AND OPERATION DATA

Plant	Type Treatment Works	Connected Population	Design Data: Digestion Tanks: No. Units	Type	Total Eff. Volume Cu.Ft.(a)	Cu.Ft. Per Capita	Sludge Storage Tanks: No. Units	Total Volume Cu.Ft.	Cu.Ft. Per Capita	Total Cu.Ft. Per Capita	Sludge Beds: No. Units	Total Area Sq.Ft.	Sq.Ft. Per Capita
Aurora	DF	47,000	3	Dorr	109,000	2.32	None	.....	....	2.32	10	50,000	1.06
DeKalb	DFS	(b)8,200	1	Dorr	20,000	2.44	1(d)	20,000	2.44	4.88	8	9,600	1.17
Galesburg	DF	25,000	3	Dorr	56,000	2.24	None	.....	....	2.24	6	24,000	0.96
Peoria	DA	(c)200,000	4	Dorr	622,000	3.11	2	850,000	4.25	7.36	28	280,000	1.40
Rockford	D	75,000	2	Hardinge	86,000	1.15	2	200,000	2.67	3.82	7	70,000	0.93
Springfield	DA	70,000	4	Downes	116,000	1.66	2(e)	57,000	0.81	2.47	12(g)	30,000	0.43

Plant	Type Treatment Works	Connected Population	Operation Data: Ave. Sewage Flow M.G.D.	Dry Solids to Digestor Pounds: Per Capita Per Day	Total Per Day	Est. Dry Sludge Produced Cu.Yds. Per Yr.	Ave. Daily Gas(f) Cu.Ft.	Use of Gas
Aurora	DF	47,000	6.9	0.088	4,140	1,110	31,100	Incineration, heating.
DeKalb	DFS	(b)8,200	1.0	0.243	1,990	400	9,200	Heating.
Galesburg	DF	25,000	2.5	0.068	1,690	600	13,800	Heating.
Peoria	DA	(c)200,000	9.9	(c)0.177	35,300	10,000	281,100	Heating.
Rockford	D	75,000	6.6	0.106	7,970	1,950	43,400	Incineration, heating.
Springfield	DA	70,000	6.7	0.113	7,940	2,050	40,600	Power, heating.

D—Separate sedimentation and digestion.
F—Sprinkling filter.
S—Secondary settling.
A—Activated sludge.

(a) Effective volume taken as volume 2 feet from top.
(b) Includes 0.15 m.g.d. cannery wastes during canning season.
(c) Population load of 90,000 plus beer slop wastes equivalent to 110,000 on volatile solids basis.
(d) Old septic tank used.
(e) Same as digestion tanks except are open and unheated and thus listed as storage units. Will soon be covered and heated.
(f) Only gas from digestion tanks measured.
(g) Two units covered with glass.

foot for those without mechanical equipment. Open sludge storage tanks averaged about 20 cents per cubic foot. Sludge bed costs varied from 20 cents to 74 cents per square foot for uncovered beds; but, the average for those not requiring special construction was about 30 cents.

Operation costs (Table 2) were more difficult to set up, because detailed records of the cost of operating each plant unit are not ordinarily kept. The estimates were based on judgment and actual experience at each plant and are considered reasonably accurate and dependable. Labor and supervision costs were developed from the operating procedure and power and maintenance costs were carefully estimated. The cost of removing dried sludge from the drying beds averaged about 40 cents per yard. Re-sanding requirements for sludge beds varied from $1.00 to $6.00 per 1,000 square feet per year and reflect the variable loading of the beds.

No Credit Allowed for Gas Values

The gross unit costs (Table 2 and 3) represent the total outlay for sludge treatment and disposal without crediting the plant with the gas produced or the sludge sold. Dried sludge is sold at all the plants except Springfield and Peoria but the revenue derived from its sale is relatively small. Springfield, through a gas engine installation, is the only plant realizing anywhere near the full possible return from gas utilization for power development. The only value which can be credited the gas produced at the other plants at this time is for heating the buildings and at Aurora and Rockford also for incineration of screenings. Gas engine power plants are being considered at Aurora, Rockford and Peoria. At Peoria an unusually large amount of gas is produced because of the presence of industrial wastes in the sewage and very favorable power plant operation will be

TABLE 2—SLUDGE DIGESTION, DRYING AND DISPOSAL COSTS

Plant	Type Sludge Digested	Construction Costs—($): Digestion Units: Digestors (a)	Storage Tanks	Total	Drying Beds	Total
Aurora	R	59,900	None	59,900	10,100	70,000
DeKalb	RS	13,290	5,000	18,290	5,600	23,890
Galesburg	R	51,120	None	51,120	6,840	57,960
Peoria	RA	329,263	109,984	439,247	112,738	551,985
Rockford	R	37,095	24,288	61,383	20,553	81,936
Springfield	RA	42,016	12,500	54,516	29,674	85,190

Plant	Type Sludge Digested	Annual Fixed and Operation Costs—($): Digestion Units: Fixed	Operation (b)	Total	Drying Beds: Fixed	Operation (c)	Total	Total	Percent Drying of Total	Per Capita Yearly	Per M.G. Sewage Treated	Per Ton Dry Solids to Digestors
Aurora	R	4,792	3,320	8,112	808	525	1,333	9,445	14.2	0.201	3.75	12.50
DeKalb	RS	1,463	940	2,403	448	190	638	3,041	21.0	0.371	8.34	8.39
Galesburg	R	4,090	1,680	5,770	546	320	866	6,636	13.1	0.265	7.27	21.50
Peoria	RA	35,200	29,200	45,400	9,020	5,500	14,520	59,920	24.3	0.299(d)	16.59	9.30
Rockford	R	4,910	5,050	9,960	1,644	875	2,519	12,479	20.2	0.166	5.18	8.56
Springfield	RA	4,365	2,425	6,790	2,375	1,200	3,573	10,365	34.5	0.148	4.24	7.15

Plant	Type Sludge Digested	Annual Return—($): Sale of Sludge	Use of Gas	Total	Total Annual	Net Costs—($): Per Capita Yearly	Per M.G. Sewage Treated	Per Ton Dry Solids to Digestors
Aurora	R	35	300	335	9,110	0.194	3.62	12.06
DeKalb	RS	50	40	90	2,951	0.360	8.08	8.12
Galesburg	R	100	100	200	6,436	0.257	7.05	20.82
Peoria	RA	None	300	300	59,620	(d)0.298	16.50	9.25
Rockford	R	300	200	500	11,979	0.160	4.97	8.23
Springfield	RA	None	5,200	5,200	5,165	0.074	2.12	3.57

R—Raw from primary.
A—Waste activated.
S—Sprinkling filter humus.

(a) Includes sludge and water pumps and piping, gas collection and heating equipment.
(b) Includes labor and power for operating sludge and water pumps and mechanical digestor equipment, laboratory and superintendence and miscellaneous supplies, and maintenance.
(c) Includes labor for dried sludge removal, resanding beds and other maintenance.
(d) Based on population equivalent.

TABLE 3—UNIT COSTS

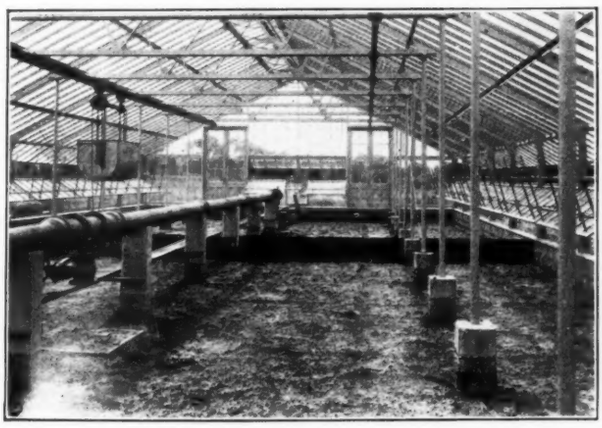
Plant	Construction—($) Digestion and Storage—Per Capita Served	Digestion and Storage—Per M.G.D. Treated	Digestion and Storage—Per Ton Dry Raw Solids Daily	Drying Beds—Per Capita Served	Drying Beds—Per M.G.D. Treated	Drying Beds—Per Ton Dry Raw Solids Daily	Total—Per Capita Served	Total—Per M.G.D. Treated	Total—Per Ton Dry Raw Solids Daily
Aurora	1.27	8,680	28,900	0.22	1,470	4,880	1.49	10,150	33,780
DeKalb	2.23	18,290	18,400	0.68	5,600	5,640	2.91	23,890	24,040
Galesburg	2.04	20,450	60,500	0.27	2,740	8,100	2.31	23,190	68,600
Peoria	2.20	44,400	24,850	0.56	11,400	6,390	2.76	55,800	31,240
Rockford	0.82	9,300	15,400	0.29	3,110	5,150	1.11	12,410	20,550
Springfield	0.78	8,140	13,800	0.42	4,440	7,480	1.20	12,580	21,280

Plant	Fixed and Operation—($) Digestion—Per Capita Yearly	Digestion—Per M.G. Treated	Digestion—Per Ton Dry Raw Solids	Drying—Per Capita Yearly	Drying—Per M.G. Treated	Drying—Per Ton Dry Raw Solids	Total—Per Capita Yearly	Total—Per M.G. Treated	Total—Per Ton Dry Raw Solids
Aurora	.173	3.22	10.74	.028	0.53	1.76	0.201	3.92	12.50
DeKalb	.293	6.58	6.61	.079	1.75	1.78	0.372	8.32	8.39
Galesburg	.231	6.32	18.70	.035	0.95	2.80	0.265	7.27	21.50
Peoria	.226	12.58	7.04	.073	4.01	2.26	0.299	16.59	9.30
Rockford	.133	4.14	6.85	.034	1.04	1.71	0.167	5.21	8.56
Springfield	.097	2.78	4.68	.051	1.46	2.47	0.148	4.24	7.15

Plant	Return—($) Per Capita Yearly	Return—($) Per M.G. Treated	Return—($) Per Ton Dry Raw Solids	Net Total Fixed and Operation—($) Per Capita Yearly	Net Total Fixed and Operation—($) Per M.G. Treated	Net Total Fixed and Operation—($) Per Ton Dry Raw Solids
Aurora	.007	0.13	0.44	0.194	3.62	12.06
DeKalb	.012	0.24	0.25	0.360	8.08	8.12
Galesburg	.008	0.22	0.68	0.257	7.05	20.82
Peoria	.001	0.09	0.05	0.298	16.50	9.25
Rockford	.007	0.21	0.35	0.167	4.97	8.23
Springfield	.074	2.12	3.58	0.074	2.12	3.57

possible. The power requirements at DeKalb and Galesburg are such that power development with gas engines would possibly not be financially sound.

Although caution must be exercised in comparing the unit costs, which have not been adjusted to a common basis, it is nevertheless interesting to note that at Peoria and DeKalb where the solids concentrations are high the per capita yearly and per million gallon figures are high and the costs per ton of dry solids placed in the digesters are low. At Galesburg and Aurora, where weak combined sewage is treated, the opposite is true. All four of these plants have the same type of digestion equipment. If these cost figures were adjusted to a common basis of design, making allowance for the difference in qualities of the raw sewage, the same general difference in these unit costs would probably hold true although the actual figures and the ratio would be changed somewhat.



Modern Covered Sludge Bed. Note Inward Swing of Bottom Sash.

For convenience and to help visualize the unit costs a summary of such costs is presented in Table 3 although some of the columns in that table repeat some of the columns in Table 2. In this table the costs for the digestion and storage tanks have been grouped together. Sludge drying comprises about 20 per cent of the total cost as an average of the six plants, the range from 14 to nearly 35 per cent.

Although the main purpose of this study was to determine reasonably accurate and dependable fixed and operating costs for the digestion, drying and disposing of sludge, using present conventional standard methods, one of the most interesting findings from this study is the wide variation in the unit loadings (Table 1) and the unit construction costs (Table 3) especially in the figures based on the dry solids received for digestion. These wide variations show that our present basis of design needs more analytical and scientific attention—i.e., in addition to a consideration of population and volume loadings we must record and analyze and give more consideration to the character of the sewage to be handled, especially the solids per unit of volume and the character of those solids. As indicated earlier in this paper we hope to undertake a study of the large amount of analytical data that is available for the six plants and study this with the operation data and costs presented in this paper and ask the person in charge of each of the six plants to help determine a scientific basis of design for units handling such kinds of sewage and to adjust the unit costs on such determined unit capacities for his tanks and beds.

In order to facilitate the comparison of unit costs of the six plants studied with the cost figures presented in the paper to follow on the mechanical dewatering of raw and digested sludge, or any future figures or estimates for mechanical dewatering, Tables 4 and 5 were

TABLE NO. 4—UNIT COSTS FOR SAND DRYING OF SLUDGE.

Plant	Tons Dry Solids Raw Daily	Cost Per Ton Dry Raw Solids—Fixed Charges	Cost Per Ton Dry Raw Solids—Operating Costs	Cost Per Ton Dry Raw Solids—Total	Tons Dry Solids Digested Daily*	Cost Per Ton Dry Digested Solids—Fixed Charges**	Cost Per Ton Dry Digested Solids—Operating Costs	Cost Per Ton Dry Digested Solids—Total**
Aurora	2.07	$1.06	$0.70	$1.76	1.24	$1.77	$1.17	$2.94
DeKalb	0.995	1.23	0.52	1.75	.60	2.07	0.87	2.94
Galesburg	0.845	1.77	1.03	2.80	.51	2.95	1.72	4.67
Peoria	17.65	1.40	0.85	2.26	10.60	2.33	1.44	3.77
Rockford	3.985	1.13	0.60	1.73	2.39	1.88	1.00	2.88
Springfield	3.97	1.64	0.83	2.47	2.38	2.73	1.39	4.12

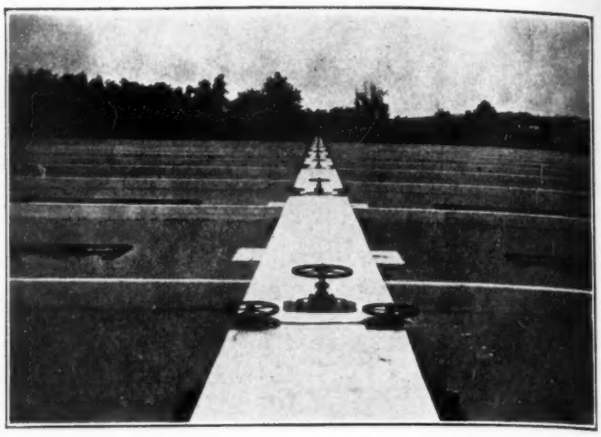
*Based on a 40% reduction in digestion

**No interest or depreciation on sludge storage tanks is included.

TABLE NO. 5—UNIT COSTS FOR SLUDGE DIGESTION AND SAND DRYING.

Plant	Tons Dry Raw Solids to Digestors Daily	Cost Per Ton Dry Raw Solids—Fixed Charges	Cost Per Ton Dry Raw Solids—Operating Costs	Cost Per Ton Dry Raw Solids—Total
Aurora	2.07	$ 7.41	$ 5.09	$12.50
DeKalb	0.995	5.27	3.12	8.39
Galesburg	0.845	15.01	6.49	21.50
Peoria	17.65	6.86	2.44	9.30
Rockford	3.985	4.50	4.06	8.56
Springfield	3.97	4.65	2.50	7.15

prepared. Sludge storage tanks are not included in the cost shown in Table 4. Wherever sufficient areas are obtainable, for digestion tanks and drying beds, the installation of mechanical dewatering equipment for either raw or digested sludge would not be sound unless reasonably dependable cost estimates for such mechanical dewatering will show them to be lower than those presented in these tables, taking into consideration the plant loadings and the qualities of the sewage handled by the six plants studied. Even though the present loadings and the unit costs given in Tables 1 and 3 (after mentally making some allowance for the different qualities of the sewages handled) reveal that the designs are not balanced as regards one plant with another or the different units within the same plant. Therefore, the further studies and adjustments previously mentioned should and we hope will be made. We trust none the less that the *actual* cost figures presented in the several tables will be of real value to engineers when designing new or additions to existing sewage-treatment works and especially when considering whether or not present sludge digestion and drying procedure should be employed or provision made for mechanical dewatering with subsequent incineration or other disposal of the sludge without nuisance.



Modern Open Sludge Drying Beds.

Part II—The Economics of Mechanical Sludge Dewatering and Disposal

By SAMUAL A. GREELY and C. R. VELZEY*

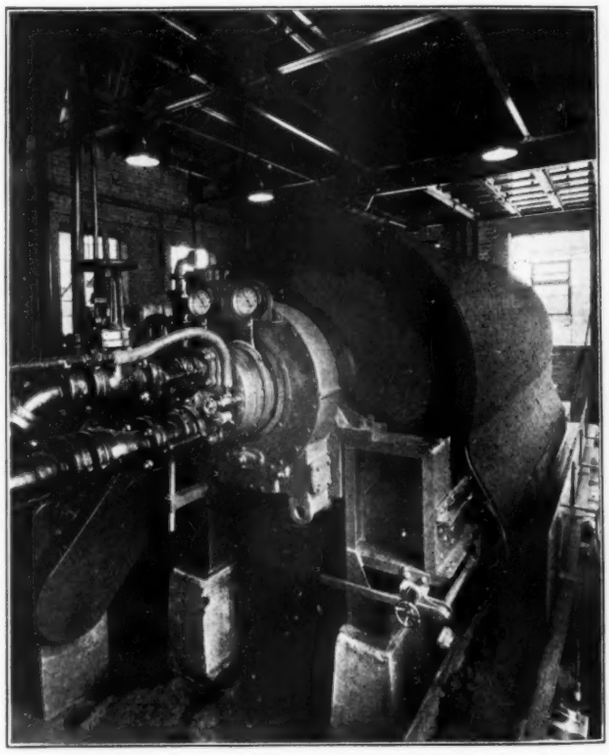
IN discussing the filtration of sludge, there are two general classifications of sludges which may well be considered separately, namely, raw sludge and digested sludge. Raw sludge may be sludge from primary sedimentation, activated sludge, a mixture of the two, or a combined sludge resulting from returning waste activated sludge to the primary tanks or in other ways mixing the two. Digested sludge may be sludge from primary sedimentation only or may be a digested mixture of primary and activated sludge. This paper is limited to a discussion of sludge de-watering by vacuum filters.

Filtration is not of itself a complete process of sludge disposal, and methods of final disposal and their cost are therefore a factor in the economics of filtration.

For the filtration of digested sludge the digestion process is for the present the same as for drying on sand beds. The filter cake, however, contains more moisture than sludges dried on sand, and this may affect the cost of final disposal. If sludge is dumped, the only difference in cost is that resulting from the greater tonnage and volume of the relatively wet filter cake. If sludge is incinerated or dried and prepared for marketing as fertilizer, the moisture content of the cake is an important factor.

A comparison of sludge disposal costs by different methods should include all the items required for a final disposal. Some typical procedures are as follows:

A—Digestion
  Vacuum Filtration
  Dumping of Sludge Cake
B—Vacuum Filtration of Raw Sludge
  Burial of Sludge Cake
C—Vacuum Filtration of Raw Sludge
  Hot Air or Steam Drying
  Incineration
  Dumping Residue.



Vacuum Sludge Filter, Cleveland, O.

In the following computations disposal by method "A" above is the only one considered. Loss of by-products also enter the picture when methods of treating raw sludge are considered. Gas from the digestion of raw sludge has considerable value for power and heat, and the dried solids may have some value as fertilizer. Filter cake from raw sludge has a heat content of some value.

*Greely and Hansen, Consulting Engineers, Chicago, Ill.

In the brief experience so far obtained, its heat output has only been used to dry the cake preparatory to incineration. As fertilizer, the solids from raw sludge have somewhat more value than those from digested sludge.

There has not been sufficient experience in the filtration of sludge and the supplementary processes to draw definite conclusions as regards cost and cost comparisons from available operating data. Experimental work on filtering sludge at Baltimore is described by Keefer and Cromwell in Sewage Works Journal of November, 1932. Most of this work was on a digested primary sludge, but a few short runs were also made on semi-digested and raw sludge. In this paper, the operating data are given and also an estimate of costs applying to the Baltimore sludge. Milwaukee has filtered undigested activated sludge for some years. On other sludges, there has been only a little experimental work done, and there has therefore been very little operating experience to indicate costs. Because of the limited experience in filtration, the following estimates of costs will be approximate, built up from such operating and experimental data as are available. They will be confined to filtration of raw primary and digested primary sludge. That these estimates do not have general application must be borne in mind, not only because of lack of supporting experience, but also because variations in the nature of sludge may materially affect filtering rates, amounts of chemicals required, moisture content of filter cake and other factors. For these reasons cost estimates will be made for hypothetical cases of an average domestic sewage rather than attempting to apply the estimate to any particular existing plant.

For the analysis, five different population loads will be computed and the following assumption will be made:

1. Populations, 10,000, 25,000, 50,000, 100,000 and 200,000.
2. Flow—100 gallons per capita per day.
3. Suspended solids in raw sewage—200 p.p.m.
4. Removal by primary settling—50 per cent.
5. Reduction of solids by digestion—40 per cent.

It will be assumed that the percentage removal given above indicates the amount of solids going to the filters, although in complete treatment there may be some reduction in the aeration process.

Variations in Chemical Requirement and Filter Rates

Filter rates and chemical dosing vary with the nature and condition of the sludge. At Baltimore it was found that filtering was possible over a wide range of coagulant addition and that in general filter rates were higher with higher doses. The most economical operation results from the proper balance between these two factors. In addition to the other variables affecting this balance, the price of chemical will vary with geographical location and amount used.

As a basis for these computations, it will be assumed that chemicals will be used as a coagulant in doses as follows, and that the following filter rates will be obtained:

Type of Sludge	$FeCl_3$ per 100 lbs. dry solids	CaO per 100 lbs. dry solids	Filter rate lbs. dry solids per sq. ft. filter
Raw primary....	3	12	3
Digested primary	6	..	5

Table 1 gives the quantities of solids on a dry basis resulting from these assumptions and used in these estimates.

TABLE 1—COST ITEMS IN SLUDGE FILTRATION
SOLIDS TO BE FILTERED

Population Served	Raw Sewage	Raw Primary Sludge	Digested Primary Sludge
	—Pounds Solids per 24 hours—Dry Basis—		
10,000	1,660	830	500
25,000	4,150	2,075	1,240
50,000	8,300	4,650	2,800
100,000	16,600	8,300	5,000
200,000	33,200	16,600	10,000

An important factor in cost of filter equipment is the area required to meet peak loads and as standby for breakdowns. The peaks in daily production of sludge are a maximum in filtering raw sludge, but for digested sludge are largely taken up by the capacity of digestion tanks. In these estimates, it is assumed that peaks of 25 per cent over the average must be met by additional filter area for digested sludge, and 100 per cent over the average for raw sludge.

There is considerable flexibility in load carrying ability provided in operation, particularly where it is assumed that the filter runs for only one shift a day. It is obvious that a few hours extra per day will filter a considerably increased amount of sludge. Experience indicates that increasing ferric chloride increases filter rates. Thus an increase in daily output of a filter plant, either to take care of peaks in sludge quantities or to make up for shut downs, can be accomplished by a temporary increase in chemical treatment.

Installation and Operating Costs

Table 2 shows the computation of filter costs and the costs of buildings and accessories and the estimated total costs of filter plants for the two types of sludge and various population loads.

Operating costs are estimated as there is practically no experience from which actual costs can be obtained. It will be seen that the cost of chemicals is a large factor in operation cost in the larger plants, and the price of chemicals is therefore important. It is assumed that ferric chloride costs $0.02 per pound and lime $0.005 per pound. Some allowance is made for supervision in proportion to solids filtered.

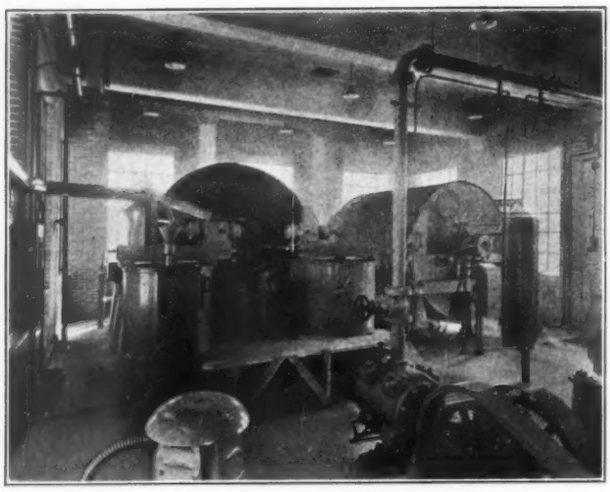
Labor for filtration is a small factor in the larger plants. It is estimated that one man can operate a filter plant producing 10 tons or more of dry solids per 8 hour

TABLE 2—COST ITEMS IN SLUDGE FILTRATION
(Estimated Cost of Filter Plants)

Population	Sludge to filters lbs. per 24 hrs. (dry basis)	Filter Area req'd, sq. ft.	No. units	Estimated Costs: Equipment	Filter Building	Accessories	Total
Raw Primary Sludge—Filter Rate = 3 lbs./sq. ft./hr. = 115 lbs./sq. ft./week							
10,000	830	104	2	$14,400	$ 4,100	$ 6,000	$ 24,500
25,000	2,075	252	2	26,000	4,600	7,700	38,300
50,000	4,150	504	2	34,700	8,000	9,600	52,300
100,000	8,300	1,008	3	63,800	9,600	10,700	84,100
200,000	16,600	2,016	3	92,700	11,000	16,600	120,300
Digested Primary Sludge—Filter Rate = 5 lbs./sq. ft./hr. = 192 lbs./sq. ft./week							
10 000	500	23	1	3,700	2,700	3,000	9,400
25,000	1,240	56	1	8,900	3,200	5,000	17,100
50,000	2,500	114	1	11,800	3.700	6,000	21,500
100,000	5,000	226	1	17,000	4,100	7,500	28,600
200,000	10,000	455	1	25.000	4,600	9,000	38,600

Note.—The sizes of vacuum filters included are 3'0" diameter × 2'3" face to 11'6" diameter × 12'2" face.

Included with filters are vacuum pump, filtrate pump, blower, sludge dosing machine, vacuum receiver, and moisture trap. Accessories include chemical mixing and storage tanks, scales, conveyors, piping and valves, loading hopper, and a charge for a truck.



Vacuum Sludge Filters at Hagerstown, Md.

shift. Some labor will be required for disposal after filtering. For simplicity it will be assumed that digested sludge cake can be dumped and that raw sludge cake can be buried; and a labor cost is included for these two operations. On this basis labor is estimated at from one to three men. In Table 3 is given the estimated operating cost.

TABLE 3—COST ITEMS IN SLUDGE FILTRATION OPERATING COSTS

Population	Sludge to filters, lbs. per 24 hrs. dry basis	Costs					
		Chemicals	Supervision	Labor	Repair and supplies	Power	Total
Raw Primary Sludge							
10,000	830	$ 310	$200	$2,500	$ 380	$ 120	$3,150
25,000	2,075	750	300	3,000	590	300	4,940
50,000	4,150	1,510	400	3,500	800	550	6,760
100,000	8,300	3,030	500	4,000	1,280	1,000	8,810
200,000	16,600	6,060	600	5,000	1,500	1,800	14,000
Digested Primary Sludge							
10,000	500	218	200	1,500	180	70	2,168
25,000	1,240	585	200	1,500	300	130	2,715
50,000	2,500	1,090	300	1,500	430	350	[1]3,670
100,000	5,000	2,190	400	1,500	570	600	[2]5,260
200,000	10,000	4,380	500	2,000	700	1,000	8,580

[1]Equivalent to roughly $5.00 per ton of dry crude solids removed by the plant.

[2]Equivalent to roughly $3.35 per ton of dry crude solids removed by the plant.

The total cost is made up of operating costs and fixed charges. Because of the large amount of equipment in the filter plant fixed charges are taken at 10 per cent. Table 4 gives the total costs and various unit costs which may be useful in comparing different methods of disposing of sludge. The cost per unit weight of dry raw sludge solids is the best to use in comparisons, as that is the only real common denominator for all methods.

Figure 1 shows graphically the estimated cost of filtering per ton of raw solids (dry basis) for plants of various sizes. The estimates made herein probably represent approximately minimum costs. If chemical costs can be reduced by lower prices or lower rates of dosing, and building costs reduced by reducing clearances and using the simplest construction, the total annual costs might be reduced to somewhat below these estimates. On the other hand an increase in these items would result in an increase in costs. The band on the figure represents an approximate range of costs applying to varying prices and conditions.

Attention is again drawn to the futility of trying to make any general application of these estimates in comparing different methods of sludge treatment and disposal. Factors such as cost of chemicals, amount of chemical required by any particular sludge, rates of filtration which will vary with the nature of the sludge, costs of sand bed construction which varies with need of covering, amount of excavation involved, need of retaining walls and the like, all have a material bearing on total costs and point to the necessity of making an analysis of each individual case to determine the most economical method of sludge disposal.

TABLE 4—COST ITEMS IN SLUDGE FILTRATION TOTAL COSTS

Population	Raw sludge per 24 hrs. lbs. (dry basis)	Fixed charges at 10%	Operating costs	Total annual costs	Unit Costs—Per capita	Unit Costs—Per M.G.	Unit Costs—Per ton solids (raw sludge dry basis)
Raw Primary Sludge							
10,000	830	$2,450	$3,510	$5,960	$0.60	$16.30	$39.30
25,000	2,075	3,830	4,940	8,770	0.35	9.60	23.20
50,000	4,150	5,230	6,760	11,990	0.24	6.50	15.80
100,000	8,300	8,410	8,810	17,220	0.17	4.70	11.40
200,000	16,600	12,030	14,960	26,990	0.14	3.70	8.90
Digested Primary Sludge							
10,000	830	940	2,168	3,108	0.31	8.70	20.50
25,000	2,075	1,710	2,715	4,425	0.18	4.80	11.70
50,000	4,150	2,150	3,670	5,820	0.12	3.20	7.70
100,000	8,300	2,860	5,260	8,120	0.08	2.20	5.35
200,000	16,600	3,860	8,580	12,440	0.06	1.70	4.10

Acknowledgement.—The above paper and that preceding it were presented at the Annual Meeting of the Illinois Society of Engineers.

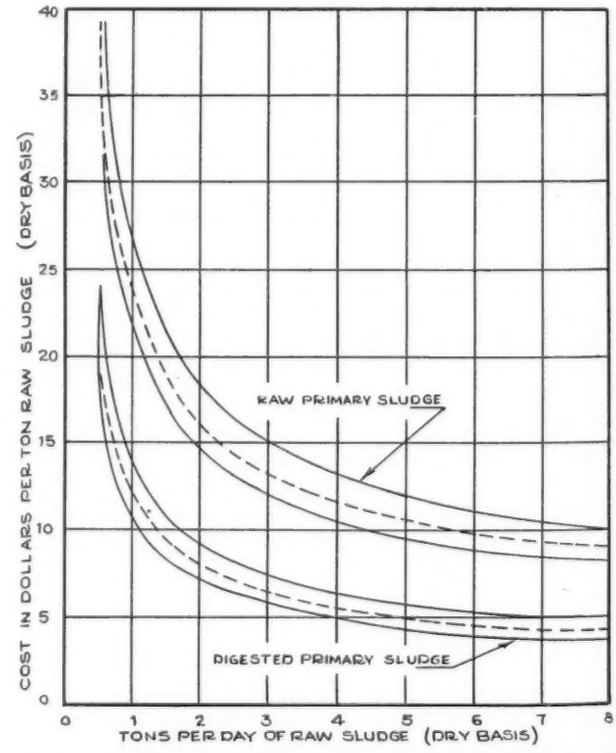
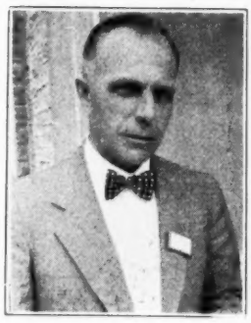


Fig. 1. Cost Items in Filtration Cost per Ton of Raw Sludge

ALGAE GROWTH RAISES pH OF WATER

Some Observations at the Coatesville Water Works

By WILLIAM C. EMIGH
City Engineer, Coatesville, Pa.



William C. Emigh

WHEN invited to present a short paper during the "trouble-hour" of this conference the speaker's reply was that there were no serious troubles at the Coatesville Water Works. We prefer to consider the problems which present themselves in operation from time to time more in the nature of interesting challenges than as "troubles." We are, therefore, glad to exchange experiences with other water works men in this informal manner.

The System Supplying Coatesville

The principal features of the water works of the city of Coatesville include a dam impounding approximately 330 million gallons of surface water; two units of slow sand filters having capacities of approximately 550,000 gallons per day each; three units of rapid sand filters with capacities of approximately 650,000 gallons per day each, with the usual accessories for chemical feed, mixing and settling; chlorination equipment; gravity flow of filtered water through cast iron pipe to the city, a distance of approximately two and one-half miles; about 26 miles of distribution mains; and a distribution reservoir of two million gallons' capacity within the city boundaries.

About 10 per cent of the water filtered is pumped from one of the city low service mains into the mains of the high service. A standpipe on a nearby hill having a capacity of 250,000 gallons floats upon the high service system. The slow sand filter units are used only when washing a rapid sand unit or when pumping into the elevated wash water tank.

The water is moderately soft but carries a high iron content. The water shed is sparsely populated and is used in part for agricultural purposes. That not so used is in woodland.

Taste, Odor and Corrosion Corrected

In August, 1931, at which time the speaker took charge of the municipally owned waterworks system, the water was in a very unsatisfactory condition due to objectionable taste, odor, and color. Analyses made by the State Department of Health indicated an iron content of 0.7 p.p.m. in the raw water, from 0.4 to 2.4 p.p.m. in the water drawn from city taps on the low service, and 4.8 p.p.m. in water from a tap on the high service. It appeared that the objectionable quality of the water was due to the presence of algae in considerable numbers in the raw water, and a corrosive filtered water which increased its iron content and color roughly in proportion to its length of stay in the pipe system.

During the late summer and early autumn of 1931, copper sulphate was used in the impounding reservoir to combat the algae. Some experimenting was done in the treatment of the water to reduce the color and other objectionable qualities due to the high iron content. No head was available between the impounding reservoir and the filters for aeration. The purpose, however, was quite satisfactorily accomplished by the use of soda ash to reduce the carbon dioxide and thus the corrosive character of the water.

Influence of Algae on pH Value of Raw Water

In June of 1932 the making of daily pH determinations was begun. During that summer an interesting relation was noted between the pH readings and the algae present in the water. The pH determinations for several months of 1932 have been plotted on the accompanying chart (Fig. 1), on which have also been indicated the applications of copper sulphate. It will be noted that the pH readings extend over a considerable range from 7.1 to 9.0. The rise was fairly uniform, but following the application of copper sulphate the pH fell off quite sharply. The parallel effect upon the alkalinity has been noted and published by others, but the speaker does not recall having seen this effect with respect to the hydrogen ion concentrations published. It appears that during the life of the plant organisms the carbon dioxide

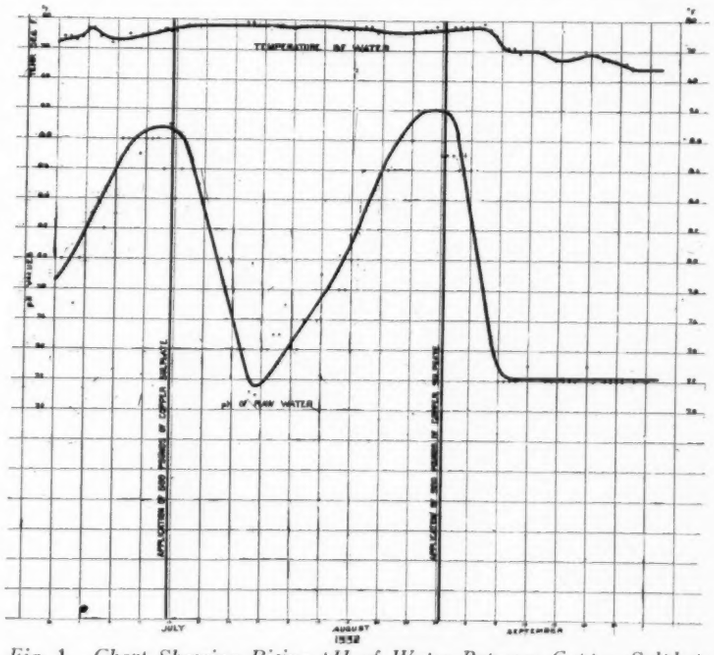


Fig. 1. Chart Showing Rising pH of Water Between Copper Sulphate Treatments, and Its Recession Following Treatments of Coatsville Reservoir.

Note: This paper, presented before the Pennsylvania Water Works Operators' Association at State College, Pa., June 26, 1934, won the President's Prize voted to the author of the best paper on operating problems. The award was a two-year subscription to Water Works and Sewerage.

content of the water is reduced owing to its absorption or consumption by the organisms. Eventually the free carbon dioxide is completely exhausted (pH 8.2) and the organisms break down the bicarbonates, thereafter to secure the half-bound carbon dioxide, with the result that normal carbonates result and the pH mounts to 9.0 or even higher. When the organisms are killed by the application of copper sulphate, the return of carbon dioxide is quickly apparent, with a corresponding reduction in alkalinity and lowering of pH. It is also possible that the decomposition of the algae evolves additional carbon dioxide.

In the early summer of 1933 it appeared that an experience similar to that of the preceding summer might be anticipated. The pH had risen gradually from 7.2 to 8.6 when in the latter part of June a rain and run-off of flood proportions occurred. The result of the displacement of the comparatively clear water in the impounding reservoir by turbid water was an immediate drop in the pH to a point considerably below the pH of what might be considered the normal winter water. During the summer the heavy rain was followed by several others of like proportions, which kept the pH down to values around 6.6 during the entire summer. In the autumn it rose to 7.2, at which it continued quite uniformly throughout the winter. The pH of the filtered water has, however, been maintained for some time around 7.9 and 8.0 by the addition of hydrated lime between the settling basin and filters. This precaution against red water appears justified when considering its perennial recurrence prior to 1932. Carbon dioxide determinations indicate that, at pH 8.0, the free carbon dioxide is generally reduced to zero or ½ p.p.m. During the summer the temperature of the raw water rises to about 79 degrees Fahrenheit and in winter drops to as low as 35 degrees.

Reservoir Overturn and Effect on Algae Multiplication

One other interesting observation has been made recently. On a second chart shown herewith (Fig. 2) are plotted the alkalinity, the pH, and the temperature of the raw water during the months of April, May, and part of June of this year. It will be noted that the temperature changes were, as might be expected in so large a body of water, fairly progressive until May 28, when the temperature of the upper water suddenly dropped six degrees. There had been no change in the atmospheric temperature during the preceding several weeks to which could be ascribed any drop in water temperature. It is further noted that about three days after this drop in temperature the pH began to rise rapidly from 7.3 to 8.3. A corresponding rise in the alkalinity of the water occurred at about the same time. It seems quite possible that a "turnover" in the reservoir brought colder water to the upper levels. Water is usually drawn from a point about 12 feet below the surface. It is possible that, in rising, the water from the lower depths brought with it a greater concentration of algae and materials favoring their rapid growth than had previously occurred in the higher levels, but it is also quite possible that other factors entered into the increase in pH readings. For about two weeks the pH continued nearly uniform at a value of approximately 8.3.

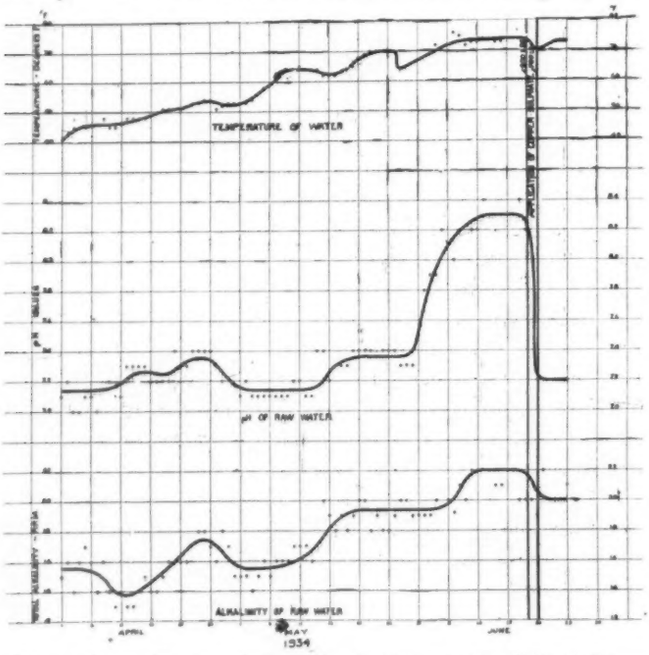


Fig. 2. Chart Showing Sharp Rise in pH and Alkalinity Following Sudden Six-Degree Temperature Drop of Surface Water in Coatesville Reservoir, May 28th. Also Effect of Adding Copper Sulphate

On June 18th the application of 900 pounds of copper sulphate was commenced, but was stopped by a heavy rain when about 200 pounds had been used. The application on the 18th was largely near the intake of the filters. The pH began to drop on the 19th and by the 20th reached 7.2. The work was completed on the 20th.

Under the microscope the predominant form of organism at the time was one which is always found in larger or smaller quantities in this water, and which the speaker has considered to be melosira. At other times asterionella have become quite numerous.

The speaker regrets that, owing to numerous other duties, he is unable to personally devote more than a few minutes of each day to the production end of the water works, and therefore is unable to follow up some of the interesting phases of the work. The foregoing observations have been presented, not with the thought of offering anything in any way complete, conclusive, or new, but more especially with the desire to compare experiences at Coatesville with those at other water works.

Damage to Water Works at Bridgeton, N. J., Closes Factories

A recent cloudburst caused a flood at Bridgeton, N. J., which so damaged its water works system—especially the pumping station and filtration plant—as to render it necessary to resort to wells for an emergency supply of 1 M.G.D.—barely sufficient for domestic requirements. For a time the city was without water.

This condition has made it necessary to discontinue serving industrial users. In consequence, factory shut downs, throwing 2,500 people out of employment, has resulted, according to newpaper reports. An appeal has been made for Federal assistance in the way of immediate cash needed to rehabilitate the damaged properties and restore normal water service.

A suggestion from manufacturers that the polluted Cohansey River water be pumped into the mains, with notification to consumers to boil the water used for drinking, was flatly refused by city authorities.

The city which suffered great damages—all five bridges across the Cohansey River being washed away—is now served by temporary pontoon bridges thrown across by army engineers.

INCREASING THE SALABILITY OF SLUDGE

By P. N. DANIELS, C. E.*

The Author

SLUDGE—to be discussed in this article—is the product of Imhoff or separate sludge digestion tanks which after air drying on sand beds contains possibly 40 to 50 per cent moisture, is well digested and suitable for use in gardens without further preparation or conditioned, as discussed later, to improve its qualities. The majority of sewage treatment plants have fully or partially digested sludge to deal with; and, after dewatering on open sand beds or under glass the operator must either use it as a fill, give it away or, preferably, try to derive an income from it through local sales of the dry cake, as a soil improver.

In most cases under the writer's observation (covering approximately 300 plants in New Jersey), the sludge cannot be given away, not to mention selling it. Several reasons may be advanced as to why this is the case, among them being: that the sludge is poorly digested and has a bad odor; the aesthetic dislike for the source of the product; lack of knowledge on the part of the consumer as to the value of its humus content; and the lack of initiative and salesmanship on the part of the plant operator in creating a demand for the product. Another and most important drawback, assuming that none of the above reasons hold, is the condition of the sludge itself. As it comes from the beds its appearance is against it; it is lumpy and difficult to spread evenly on lawns, golf greens or gardens and if not very thoroughly raked in and pulverized—a backbreaking job—the lumps remain to become pasty and soggy (sometimes odorous) at the first rain. Such a condition is certainly not a desirable one, especially on lawns and golf greens.

Elaborate mechanisms, such as vacuum filters, driers, grinders, and pulverizers, now being installed at large modern plants, are at present very definitely beyond the reach of the average sewage plant budget, both as to first cost and operation; nor, would their purchase be justified for the smaller plants. It is therefore necessary for most operators to devise ways and means of creating a consumer-demand cheaply and with little or no budget increase, assuming of course that he desires a revenue to supplement the universally ailing municipal finances and, incidentally, to justify his own job.

Suggested Procedure for Creating Sludge Demand

The first step is to get the sludge-cake into a readily usable condition by a grinding or some other process so that it is finely and uniformly divided for spreading effectively or for mixing with other enriching ingredients when and if desirable. Lacking a drier, the sludge must be broken up as it comes from the sludge beds, which means that it is more or less damp—40 to 50 per cent moisture. Storage under cover, if available, will somewhat reduce this moisture but will increase the labor cost as the sludge must be turned over from time to time.

The simplest method for producing a granular sludge, where only small quantities are required to be sold at a price sufficient to cover the extra labor cost, is by hand screening. For larger amounts machinery is necessary and, up to recently, direct grinding of damp sludge without pre-drying was practically impossible with the then existing types of machines. Recently, however, the Royer Disintegrator, manufactured by the Royer Foundry and Machine Co. of Wilkes-Barre, Pa., a simple device long in use in the foundry field for conditioning caked molding sand and later for compost mixing for use on golf greens, gardens, lawns, etc., has appeared in the sewage field. By its use damp sludge cake can be effectively and practically shredded or granulated.

Operation of the Disintegrator

This machine consists of a hopper the bottom of which is a rapidly traveling rubber belt (1900 feet per minute), inclined at an angle of 45 degrees. This belt is studded with steel sprigs or tooth like projections which produce a shredding or combing action on the sludge cake beneath which it travels at high speed. Materials too hard to break up, such as stones, merely bounce off the teeth and gravitate to the lower end of the hopper to a discharge gate which may be opened at intervals to clear the hopper of such waste. The shredded particles, lodging in the pockets formed by the sprigs, and acting as a traveling "classifier," are thrown out at the upper end of the hopper by centrifugal action, shooting about 15 feet as a maximum before striking the ground. The accompanying photograph reveals this operation. A flexible discharge baffle permits the stream to be directed to varying elevations—depending upon whether

A Truck, one man and the Disintegrator at work. The capacity of this small machine is 4 cu. yds. per hour, using manual feed. Note the flexible baffle, which directs the discharge stream, and the uniformity of the shredded sludge.

*Superintendent of Sewage Treatment Works, Trenton, N. J.

the shredded sludge is to be piled, put in a bin, or thrown directly into a truck at the will of the operator.

At the Trenton, N. J., sewage treatment plant a Disintegrator has been in use for a sufficient period under varying conditions, to justify the following statements—at times, severe tests having been applied.

1. Frozen sludge in chunks up to 8 inches in size could be handled satisfactorily.

2. Sludge with as much as 56 per cent moisture failed to clog the machine. On test, several buckets with 90 per cent moisture were passed through without its remaining in the belt sprig pockets.

3. The machine would pass sludge at the rate of 1 cu. yd. in 12 minutes, two men being required for shoveling. With hopper feed by machine from a bin or pile more than this rate could have been maintained, but with the hand feed available the men could not keep going and 4 cu. yds. per hour proved to be an average production—at a cost of 20 cents per yard on the truck or storage pile.

4. The disintegrated sludge averaged 1 to 2 millimeters (25 m.m. to the inch) in diameter. All particles passed the ½-in screen.

5. The product did not pack, even when exposed to weather, but it dried very slowly on the interior, probably due to the insulating effect of the dried outer layer.

6. As the machine has a 1.5 H.P. motor, the electrical cost did not exceed 10 cts. per hour (2.5 cts. per yard of 600 to 800 pounds) at household current rates, which will eventually be correspondingly less at power rates.

7. The total cost per yard of shredded sludge including loading by hand into dump cars, hauling about 2000 feet with gasolene locomotive, and forking into machine, was approximately 68 cts. per yard—with labor charged at 40 cts. per hour. The machine (see accompanying picture) is easily portable and probably at most plants, using sludge beds, one of the hand loadings could be dispensed with and thus reduce the cost of handling still further.

The Value of Sludge as a Soil Conditioner

Sludge produced from whatever disintegrating process that may be used is much more suitable as a soil conditioner on lawns, gardens or other horticultural and agricultural activities. It will be noted that the words "soil conditioner" are used rather than calling the sludge a fertilizer. A typical analysis of digested sludge is as follows:

	Per Cent
Total nitrogen	1.96
Ammonia nitrogen	0.12
Available nitrogen	0.76
Total phosphoric acid	0.62
Total potash	0.13

The total plant food constituents in this analysis form only 2.71 per cent of the total bulk, while commercial fertilizers run 16 per cent or more. For this reason it is believed inadvisable to sell ordinary digested sludge for anything other than it really is—a valuable source of soil humus, comparable with peat moss, compost, or rotted manure.

In this form, the sludge gives good results on lawns, golf greens, flower gardens and with other crops which do not demand large quantities of plant food from the soil. It acts slowly, but the action persists over several seasons so that an application every two years is sufficient to maintain the desired results. Sandy soils are most amenable to treatment with sludge, because the water holding capacity of the ground is increased and this becomes an important value in hot localities. The gardens and lawns at the Trenton sewage treatment plant were built up with sludge alone, starting with a sub-soil stripped of practically all top soil, and composed mostly of sand, clay, and gravel. The gardens now grow almost every variety of vegetable and flower successfully. This was accomplished by pumping wet digested sludge over the entire area for several years, applying a very thin layer by spraying from a hose.

The Question of Producing "Special" or Fortified Sludge

The last step which may and should be taken to increase the salability of sludge is to make it a specialty product by fortifying it with chemical fertilizers. As indicated previously, sludge alone is not a strong fertilizer and will not give the immediate results obtainable from the use of "Vigoro" and similar soil stimulants. The average grower, particularly the amateur gardener, wants to see a decided acceleration in growth from the use of any plant food he buys. In golf course work, the greens and fairways must be ready with a heavy early growth as soon as the season opens, and this means that the soil stimulant used must be a quick actor. As golf courses necessarily consume large quantities of humus and fertilizer yearly, they form a large potential market for the sewage plant product, provided that product is in a form that can be easily and satisfactorily used. Parks fall in the same category, but hold less attraction than do cash customers.

To determine the proper chemicals to add, some knowledge of the different compounds is necessary. The following is a most elementary outline of the subject and does not pretend to cover the entire field of fertilizer practice. It does, however, include the more common materials used, including those which are readily adaptable for mixing with sludge.

Materials Used in Fertilizer Manufacture

The three main plant foods are nitrogen, phosphoric acid, and potash. The nitrogen stimulates leafy growth and hastens maturity; the phosphoric acid produces vegetable protein, forwarding early plant growth, and strengthens plant stalks; the potash stimulates carbohydrate production in starchy crops such as potatoes and also serves in building plant tissue.

Nitrogen may be obtained in three forms, nitrate nitrogen, ammoniacal nitrogen, and organic nitrogen. In the first group are sodium nitrate, and calcium nitrate, the first being preferred for mixing. These are water soluble and are immediately available to plants. Ammoniacal nitrogen is contained in sulphate of ammonia, ammonium nitrate and phosphate of ammonia, either one mixing readily. All are water soluble, but must undergo chemical change in the soil to quicken plant growth.

Organic nitrogen is derived from sludge itself, farm by-products, such as manure and compost, tankage from slaughter-houses, fish by-products, and from synthetic nitrogen such as cyanamid and urea. Of these the one of chief interest is urea. It is a white crystalline substance selling at about 10 cents per pound, has the high nitrogen content (46 per cent) of any of the ordinarily used fertilizers, and is by far the best chem-

ical to mix with sludge to give immediate results. Cyanamid is also of growing importance as a source of fertilizer nitrogen.

The principal source of phosphoric acid is from the super-phosphates which are the products of acid treatment of rock phosphate. These vary in strength from 16 to 40 per cent P_2O_5. The grade known as 16 to 20 per cent superphosphate is more generally used and would be preferable for use with sludge. The soluble acid phosphate reverts to the slowly soluble form when applied to the soil and only becomes available to plants in the presence of organic matter. This gives sludge an important part to play, as without humus of some kind the addition of the phosphate fertilizer is unsatisfactory. Usually, soils are most deficient in phosphorus, so that the quantity used in a mixture is greater than the other two plant foods.

Potassium chloride in various concentrations forms the chief source of potash in fertilizers. Muriate of potash is the strongest, containing 48 to 60 per cent. "Manure salts" is next with 20 to 30 per cent and "Kainit" last with 10 to 14 per cent potash. For use with sludge the stronger muriate of potash is in most cases to be preferred.

Selection of a Mix and Blending

In selecting the kinds and amounts of chemicals for a sludge-fertilizer mix, a variety of considerations govern. For a cheap mix to be put on low value crops, phosphoric acid should predominate because of its low cost and the fact that most soils are deficient in that element. As the crop or "purpose" value rises (golf greens culture, for instance), the other ingredients, nitrogen and potash, should be increased proportionately. Thus, for a cheap fertilizer to cost from $2 to $3 per acre, the nitrogen, phosphoric acid, potash ratio would be 1:4:1 and for a $15 up per acre mix, 1:1½:1 is the preferred ratio. The potash portion should be increased for starchy crops such as potatoes, and also for tobacco. Heavy vegetation requires nitrogen as the principal growth maker and, as the reinforced sludge will usually be used for this type of crop, a higher proportion is advisable.

The writer has used the following formula for grass and flowers with considerable success:

	Lbs.
Sludge (dry basis)	360
Sand (filler)	100
Urea (commercial)	1
Acid-phosphate (16% P_2O_5)	50

The phosphate is blended with the sludge as it goes through the disintegrator, the urea and sand are mixed together separately by hand and then the two batches are mixed either by hand or by use of the disintegrator. The product is sold for 75 cts. per bag of 75 lbs. (40 per cent moisture sludge), a bag being enough to cover 150 sq. ft. of lawn, with two applications. The cost of this mix per 100 lbs. is roughly 26 cts., when several tons are mixed at a time and using the machine for shredding and mixing.

Results of Application

When applied to grass in a very thin layer, a vigorous dark green growth occurs inches higher than adjacent untreated sod, and the difference may be noted in about four days. This is due to the urea constituent which acts as a powerful forcing agent. Aftergrowth is well maintained as the phosphate becomes available and the sludge holds moisture and backs up the growing action still further. Potash was not used in this mixture, because the soil did not require it.

Another formula (Miller) gives the following ingredients:

	Lbs.
Dried ground sludge	1,650
Ammonium sulphate	100
Acid phosphate (20% P_2O_5)	200
Muriate of potash	50

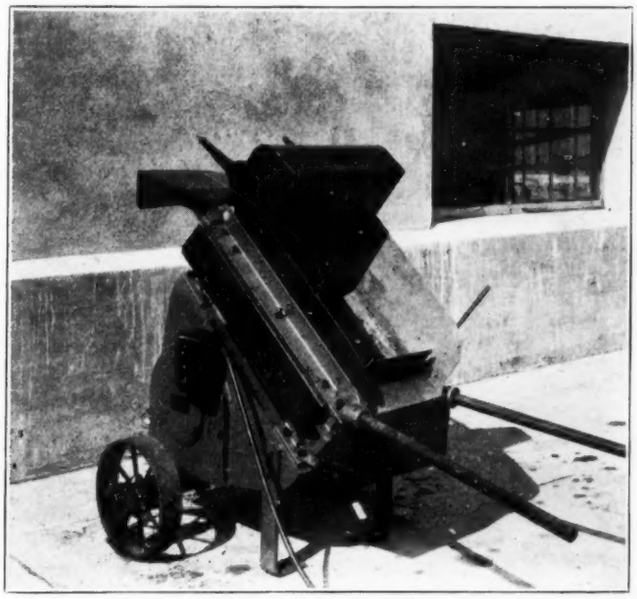
This is a better balanced mix than the one previously given, as it will be good for almost any crop or average soil.

Selling Methods

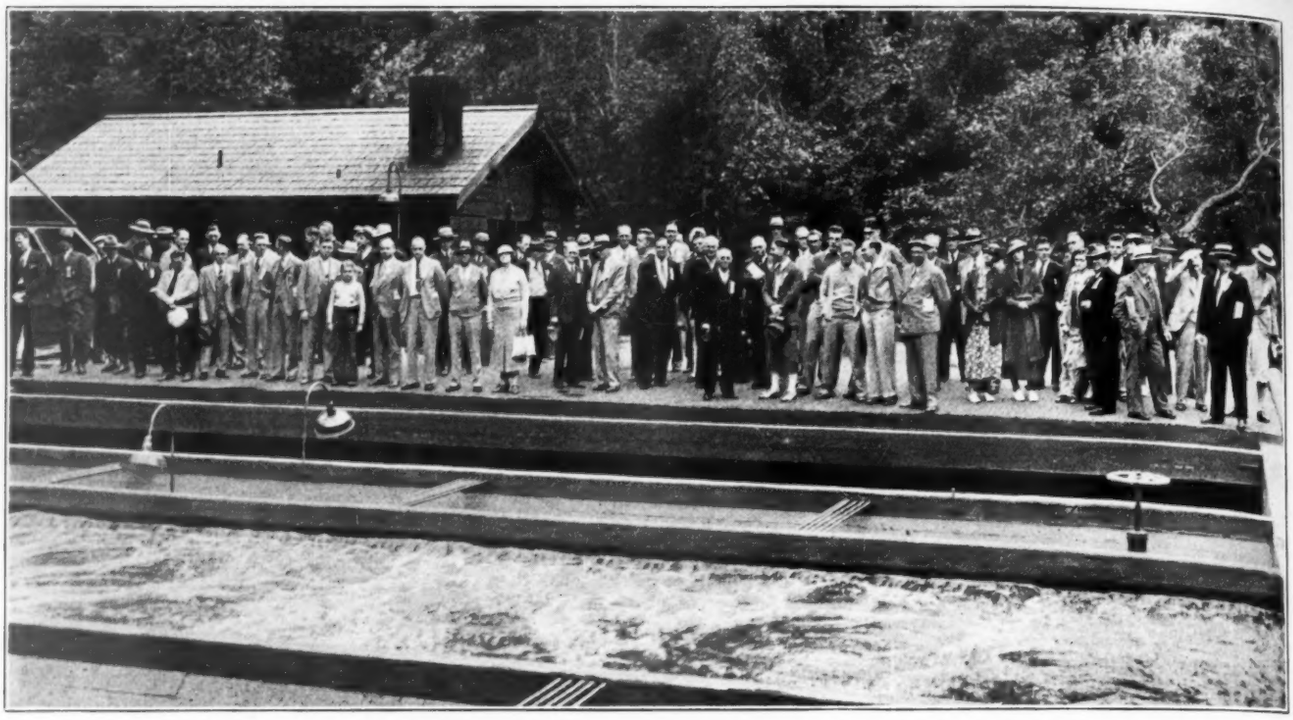
The fertilizer constituents in the above will cost about $3.85 and the sludge around $3.00, depending upon the moisture of the sludge ground. As the resulting compound is very much superior to manure at $10 to $14 per ton, there should be no difficulty in realizing a handsome profit, once the customers are acquainted with its merits.

Methods of merchandising the finished product will readily suggest themselves. A fancy name such as "Super-humus," "Grozall," or "Fortified Humus" helps a lot. Free samples to golf course superintendents and other potential customers is one way of breaking into the market. Local fertilizer dealers may be interested in serving as sales agents for the output, in that they will then sell both the raw materials and the manufactured product, making a profit each way.

The best sales argument is of course that the continued use of inorganic chemicals on the soil is injurious unless there be an addition of humus in some form. Sludge, with but little preparation, is a very cheap and plentiful source of humus and is being more widely used all the time. With some effort there is a profitable market for sludge if it is put into satisfactory condition to improve its appearance, ease of handling and availability.



The Royer Sludge Disintegrator. Note the sprigs on the belt at the bottom of hopper which forms the rapidly traveling "curry-comb" that shreds the sludge cake and catapults it from hopper to truck or storage in one operation. See picture of the disintegrator in service.



Members and Guests of the California Sewage Works Association Inspect the Activated Sludge Plant Serving Beautiful Yosemite Park.

MEETING OF THE CALIFORNIA SEWAGE WORKS ASSOCIATION*

THE Sixth Spring Conference of the California Sewage Works Association was held in Yosemite National Park where, prior to the opening of the meeting, the 1.2 M.G.D. capacity Main (activated sludge) Sewage Treatment Plant, built in 1931, at a cost of $80,000 to serve the park was inspected. The appearance of the plant was indicative of the care and attention given its operation which in turn explains the excellent results obtained.

Award of Merit for 1933 Voted Yosemite Plant

The Award of Merit—a plaque donated by Wallace and Tiernan Company to the Association for presentation annually to the member-plant showing the greatest improvement in operation—was voted this year to the Yosemite Plant, designed by H. B. Hommon, Sanitary Engineer, U. S. Public Health Service, and operated under his supervision. Colonel C. G. Thompson, Superintendent of the Park, received the plaque from President D. C. McMillan. Professors Chas. Gilman Hyde and L. B. Reynolds constituted the Committee on Awards.

Papers and Discussions

The following papers and discussions were presented in the technical sessions:

"Handling Flood Water at a Disposal Plant—the Need for Adequate Grit Basins"—A. W. WYMAN, Superintendent, Sewage Treatment Works, Pasadena, Calif.

Mr. Wyman reported, that at Pasadena's activated sludge plant during the "fifty-year" storm of December 31, 1933 (in spite of a separate sewer collecting system), the flow had increased from a normal average of 8,000,000 g.p.d. to an estimated peak of 25,000,000 gallons, whereas ordinary storms had only increased the normal flow by about 3,000,000 gallons per day. The activated sludge process was held intact during the storm but under the circumstance, grit chambers could hardly be expected to function effectively and the nitrogen content of the sludge produced following the storm dropped from 6 to 5 per cent. This resulted in a lower price per pound for the sludge fertilizer sold, but the increase in the volume of the sludge had more than offset the reduction in price per pound. For several months following the storm a very marked reduction in screenings was noticed. Mr. Wyman was of the opinion that a properly designed grit basin ahead of the plant would be of material value and said that he was impressed with a design described by H. Blunck, in Sewage Works Journal for May, 1933.

A. M. RAWN, Asst. Chief Engr., Los Angeles County Sanitation District, said that a more accurate classification of separate and combined sewers was needed as was more complete investigations as to the source of storm waters entering supposedly separate sanitary sewers. Professor Hyde suggested a future discussion dealing with "ventilation of manholes." Ventilated manhole covers, he thought, were undoubtedly a source of a lot of flood waters entering sanitary sewers, and it might be desirable to eliminate these.

"Patented Ideas in Sewage Treatment"—R. F.

*This account and digest of papers represents a condensation of a more detailed report prepared by A. C. Beyer, Sanitary Engineer, Wallace & Tiernan Co., San Francisco, Calif.—Editor.

GOUDEY, Sanitary Engineer, Department of Water and Power, Los Angeles.

Mr. Goudey, in a carefully prepared presentation, pointed out that the existing five hundred patents in the sewage field covered all phases of a sewage treatment and to an extent not generally realized even by consulting specialists in the field. About half of these patents were equipment patents and the remainder process patents; and, it would appear impossible to construct a modern high-grade sewage treatment plant without utilizing one or more of the existing patents dealing with sewage treatment. To attempt to avoid the use of patented devices or processes would be to retrogress in many cases.

Mr. Goudey found no cause for serious alarm at the situation but did feel that engineers and operators should be well acquainted with the situation in order that their client or employer might be properly advised and protected against any unreasonable demands or suits brought by holders of patents. The trend in other branches of engineering had been very much the same, the general experience being that where there are a great many patents held by a number of different firms there had been no particular difficulty in selecting economical equipment or processes and avoiding those for which excessive charges were demanded.

There was plainly an indication that the activity of patentees had been accompanied by progress in the efficiency of sewage treatment and lowering of operating costs. And, certain established firms had built up important patent structures which apparently are to be legitimately used primarily for the purpose of protecting up-to-date methods of treatment and preventing exploitation of the public. Certain other important activities in the patent field in connection with sewage treatment were not to be looked upon with favor. He counselled, that in case a notice of infringement is filed with a municipality it was important that this be not ignored. With the proper procedure an extension of time can normally be secured in which a thorough investigation can be made in order to determine whether to make a settlement, or whether by making a change in the operation in the plant, infringement can be avoided.

Mr. Goudey pointed out that many patents could be circumvented if the engineer or operator should find it necessary to do so and he cited several examples. In patented processes, developing improvements in the process, would serve; but, he added, it was only fair to recognize that if one's ideas are of a value requiring protection they must be patented.

ALVA J. SMITH, Consulting Engineer, Los Angeles, pointed out that in many cases if engineers recommended or specified patented devices or improvements it was likely that complicating disputes by competing patent holders would develop before City councils. A. M. KIVARI of the Dorr Company, G. F. BACKUS of Oliver United Filters, and J. F. SMITH, Sales Manager, Great Western Electro-Chemical Company, said in substance, that the expense of research and developmental work must be protected by taking out patents; but, felt that there would be considerable difficulty of a patentee obtaining revenue from process patents in sewage treatment.

C. C. KENNEDY, Consulting Engineer, San Francisco, was of the opinion that most mechanism patents could not be objected to, but that patented processes should be avoided if possible in most instances.

"Slime Growth in Sewers"—F. E. DEMARTINI, Junior Sanitary Engineer, California State Department of Health, Berkeley, Calif.

Mr. DeMartini listed, described and discussed the characteristics of the common slime forming organisms occurring in sewage—clodothrix, sphaerotilus, leptomitus and beggiatoa being the more common occurring. Sewage and polluted streams receiving carbohydrates (usually in the form of waste material from various types of food and canning plants) were in practically all cases likely to show slime growths—especially spaerotilus. At least some dissolved oxygen, he said, was required to sustain such growths and soft water appeared to be more favorable to development than hard water. Copper sulphate, lime and hypochlorite solution had been tried in California as a means of controlling such growths with varying degrees of success. Difficulties with slime growths at Dunsmuir had disappeared when the water system was metered and the reduced water consumption had resulted in a more concentrated and warmer sewage which contained little, if any, dissolved oxygen, after a short stay in the sewer.

Yosemite Park Plant Receives Award of Merit Plaque. Left to Right—Russell White, Chief Operator; C. R. Willette, Assistant Operator; E. M. Hilton, Park Engineer in Charge of the Plant.

PROF. CHAS. GILMAN HYDE, in discussion, pointed out the need of more definite information regarding some of these organisms—especially leptomitus, and the factors favoring their growth. He cited a case on the Truckee River and described the effects produced by polluting wastes from a pulp and paper mill which had created a very foul condition—sphaerotilus being one of the principal offending organisms. After diversion of the bulk of the waste, including all of the waste sulphite liquors, the condition of the stream rapidly improved. Prof. Hyde also called attention to the fact that sphaerotilus was frequently associated with the bulking of activated sludge.

The Utilization of Sludge Gas

A paper on the above subject, presented by Alva J. Smith of Los Angeles, at the last fall meeting, was again thrown open to discussion in which a number participated.

J. F. BYXBEE, City Engineer of Palo Alto, reviewed reports on the utilization of sludge gas at a number of plants, including those at Springfield, Ill.; Birmingham, Eng.; Berlin, Germany, Newark, N. Y.; and, the Los Angeles County Plant. From such reports it was evident that the use of sludge gas for power production was practical. After careful study of the economies involved, an installation of a 50 h.p. gas-engine to use digester gas at the new separate sludge digestion plant at Palo Alto, Calif., had been decided upon.

M. L. CRIST, Consulting Engineer, Los Angeles, pointed out that the use of gas generated as a by-product in sewage treatment had a popular appeal to laymen and municipal authorities. Its use for production of power for operating treatment plants deserved the attention it was getting.

F. S. CURRIE of the Currie Engineering Company reported the successful use of sludge gas for operating a 40 h.p. gas engine at the San Bernardino Treatment Plant. Following a reduction in the power rate and standby charge, the use of the gas engine had been discontinued. It was now proposed to use the excess gas for killing impounded stray animals and also as a fuel for an incinerator. (Installing gas engines to force reductions in power and standby charges has its merits at that.—Ed.)

A. P. BANTA, Los Angeles County Sanitation District, suggested the use of an iron oxide scrubber (such as gas companies employ) to remove the objectionable and corrosive hydrogen sulphide from sludge gas. The necessity of proper lubrication of engines operating on sludge gas, care in selecting the most adaptable make of engine and the proper carburetor were highly important factors. In boilers fired with sludge gas, the desirability of maintaining high temperatures throughout, to prevent condensation in flues with the resultant formation of sulphuric acid and corrosion, was emphasized.

"Oxidation Potential Theory Applied to Sewage"
—RICHARD D. POMEROY, Research Chemist, Los Angeles County Sanitation Dist., Los Angeles, Calif.

Mr. Pomeroy said, that certain results observed in sewage treatment are best explained in terms of oxidation potentials. Oxidizing agents familiar to the sewage chemists include potassium permanganate, chlorine, oxygen, nitrates, nitrites, ferric iron compounds. Reducing materials were represented by most organic compounds, hydrogen sulphide, ammonia, nitrites, ferrous iron.

In theoretical terms, oxidizing agents take on electrons, while reducing agents yield electrons. It is necessary not only to distinguish the strong from the weak oxidizing and reducing agents, but also to distinguish between those which tend to react very rapidly and those which react very slowly. Oxidation potential (available force of oxidizing agents) was affected not only by the *strength* of oxidizing and reducing agents but also by their *rate* of reactivity.

Mr. Pomeroy said that the presence of micro-organic life had a decided effect on oxidation potential and displayed an interesting chart showing the gradual lowering of the oxidation potential of a sewage sample due to progressive biological and chemical change. It was shown that aeration of the sample having a low oxidation potential raised it appreciably. Thereafter, the abiilty of septic sewage to serve as an electrolyte in generating electric current in a battery jar was demonstrated. Electrons flowed from the sewage into the aerated water surrounding a porous cup containing the septic sewage and the current generated was sufficient to operate a delicate electric motor built for the demonstration. He explained that current so generated would lack in practical significance because of the very low voltage attained and it could therefore not be considered as a practical source of power for sewage plant operation. It was merely intended to show the galvanic or corrosive action of septicized (reducing) sewage.

Oxidation potentials, he said, had many analogies with pH values and it seemed that oxidation potentials would become highly important in the study of sewage treatment. Oxidation potentials, he said, were determined electrically, but the proper equipment is not generally available in sewage laboratories. A colorimetric method of measurement, similar to the use of indicators in determining pH values, would be much simpler. Certain indicators such as methylene blue and others are already available, but there was room for considerable research in their application in the field of sewage treatment.

E. A. REINKE, California Department of Health, said that he was convinced that studies of oxidation potentials in sewage treatment practices would yield information of genuine value. Others concurred and urged that extended study of this interesting aspect be conducted.

A. C. BEYER pointed out the need for distinction between oxidation potential and B.O.D., similar to that made between pH values and total alkalinity or total acidity. He questioned the fact that the germicidal effect of chlorine could be explained in terms of oxidation potential, as suggested by Mr. Pomeroy, but pointed out that there was a relationship between oxidation potential and the *velocity and quality* of sterilization when comparing chlorine of high potential with substitution chlorine compounds of low potentials—such as the chloramines are.

East vs. West in Sewage Treatment

Professor Hyde presented an interesting review of impressions gained during a recent visit to various plants in eastern states; and, while attending various conferences of Sewage Works Operators and engineers. Particular attention was called to the interest shown in chemical treatment, the incineration of sludge, vacuum dewatering, and the spray drying of sludge, such as is being developed at Plainfield, N. J. His impression was, that in many parts of the eastern section and the central sections of the country the operation of sewage treatment plants was now being given more attention than in the west and he urged that every effort be made to educate both the public and political officials in regard to the value of securing efficient men and paying them adequately to operate treatment plants properly.

The fall meeting of the Association will be held on September 6th, jointly with the Public Health Engineering Section of the A. P. H. A., which meets in Pasadena, September 3rd-6th.

▼

Wm. Raisch Represents Municipal Sanitary Service Corporation

(A Correction)

In reporting the recent meeting of the New York State Sewage Works Association in our July issue, the statement that "the discussion which was opened by Wm. Raisch of Oliver United Filters was followed with considerable interest" was in error. Mr. Raisch is connected with Municipal Sanitary Service Corp., and both he and W. H. Pitkin of Oliver United Filters took part in the discussion.

▼

Indianapolis Sewage Plant to Be Enlarged

The Activated Sludge Sewage Treatment Works of Indianapolis, Ind., is definitely to be enlarged. The P.W.A. has allowed a grant of $126,000 to the Indianapolis Sanitary District to apply on this $436,400 project. The District determined to finance the project locally and accept the P.W.A. grant, representing 30 per cent of the cost of labor and material. Originally a loan with grant amounting to $395,000 had been applied for.

CONFERENCE OF THE PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION

THE Pennsylvania Water Works Operators Association held its 7th Annual Conference June 25th-27th at State College, Pa. The attendance of upwards of 220 establishes a new record. The report of Secretary I. M. Glace revealed a membership of 319—new members added during the year being 74.

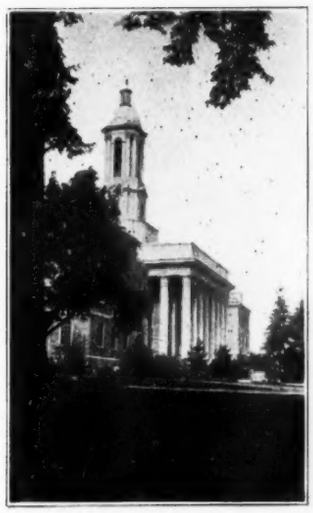
An important committee report was that of the Committee on Licensing Operators and a Short Course for Operators, which was presented by Professor E. D. Walker of State College. It was recommended and carried by vote that a Short Course for Operators be given yearly at State College, the first school to be held in February or March of 1935.

The recommendation that the Association draw up an act to be known as the Licensing Act which would require all water works operators in responsible charge of the operation of purification plants to be licensed by law, was discussed at length by members for and against such an act. The Committee recommended that the act allow temporary licenses to be issued to run for a maximum period of 3 years in which the licensee must prepare for and pass the examinations of the Licensing Board. To satisfy the opinion of several members, that further thought should be given this important step, a final vote was not taken in the meeting. A motion was carried authorizing the Committee to draft a model Licensing Act for distribution to the entire membership of the association for study and acceptance or rejection by mail baliot. From experience cited in the discussion it was evident that such an act would be a protection to public health and to qualified operators who heretofore have too frequently been displaced by incompetent political appointees.

Officers elected for the ensuing year were:
President: Harry M. Freeburn, Philadelphia, Pa.
Vice-President: Chas. L. Fox, Wilkinsburg, Pa.
Vice-President: Chas. A. Kunkle, Johnstown, Pa.
Secretary-Treasurer: I. M. Glace (re-elected) Harrisburg, Pa.

Martin E. Flentje, Community Water Service Co., Retiring President

Harry M. Freeburn, Pennsylvania State Department of Health, President-Elect



Administration Building, Pennsylvania State College

Technical Sessions

(President Martin E. Flentje presiding)

The technical sessions were opened with an excellent address by George D. Norcom, Sanitary Engineer, Federal Water Service Company, New York City, on the "Elements of Coagulation," in which Mr. Norcom laid down certain essentials in the effective conditioning of water prior to filtration; discussed the merits of filter alum and the newer ferric iron coagulants; demonstrated with the aid of an Omega Laboratory Mixer the method of determining proper coagulant dosages and coagulation control by conducting flocculation tests. He illustrated by lantern slides, and discussed the important features of the several types of mechanical mixers, coagulating and flocculation devices now in use. Mr. Norcom spoke from years of practical experience when he said that too much emphasis could not be placed on the need of close attention to and study of coagulation. This, inasmuch as conditioning of the raw water represented the heart of softening and rapid filtration processes, both as to efficiency of functioning and economy of operations.

Trouble Hour Papers

The series of short papers by several operators, presented during what is known as the "Trouble Hour," was, as is usual at the meetings of this association, filled with interest.

The prize award* offered by the president of the association for the best paper in the series was awarded by the judges to W. C. EMIGH, City Engineer and Manager of Utilities, Coatesville, Pa. To J. Z. COLUMBIA, Superintendent of Filtration, Burgettstown, Pa., went the vote of "honorable mention" for his paper.

Mr. Emigh reported coagulation difficulties traced to the rapid rise in pH of the impounded water created by rapid multiplication of organisms (algae) with melosira and asterionella predominating. After each application of copper sulphate the pH returned rapidly to a normal of 7.2 from that of 8.3 to 9.0. A sudden temperature drop had been responsible for reservoir overturn and rapid algae increase with attendant pH increase created by the breaking down of bicarbonates into carbonates by organisms extracting carbon dioxide for sustained growth. (Mr. Emigh's paper will be found in full on pages 275 and 276 in this issue of WATER WORKS AND SEWERAGE.—Editor.)

*A subscription to WATER WORKS AND SEWERAGE for two years, marking the second year that this magazine has been thus honored.

George D. Norcom, Federal Water Service Co., New York City

"Mike" Glace, Pennsylvania State Department of Health, Secretary-Treasurer

Mr. Columbia used ingenuity in locating a hidden and little suspected "cross connection" between the drain and wash-water sewer and the clear water well. The appearance of turbid water and bad taste in the finished water at intervals was traced to sewer surcharges when emptying the coagulation basins. The dirty sludge-containing water had backed up into a hidden manhole near the top of which entered a spill-pipe (overflow) from the clear well, and of which there was no record. The lesson learned was to look out for surcharged sewers at filter plants.

HARRY BARTON, Superintendent, Pittsburgh Suburban Water Company, told of leakages located on distribution system by measuring the flow through a temporary by-pass and 2 in. meter around closed valves during hours of 2 to 4 a. m.—taking 2 minute readings. The aquaphone was then used to spot the leaks revealed by the meter test on sections of the system. To meter readers locating leakage a bonus paid had brought results.

F. W. BOUSON, Chief Chemist, South Pittsburgh Water Company, reported that poor filter bed conditions had been traced to lack of perfect coagulation of water carrying mine drainage. At pH lower than 6.9 considerable iron passed the filters and above 7.0 alumina passed and after precipitation resulted. Coagulating with exact pH control between 6.8 and 7.0 had produced the most satisfactory results.

B. H. BROCK, Superintendent, Lancaster (Pa.) Suburban Water Company, described a home-made ammoniator which had improved chlorination efficiencies at little expense.

J. E. BRUNNER, Manager, Middletown and Royalton (Pa.) Water Company, told of auxiliary supply wells which had suddenly increased in hardness from 140 to 250 p.p.m. requiring softening. An automatic zeolite softening plant was under consideration at higher initial cost than a lime-soda plant.

R. H. CRONE, Superintendent of Filtration, Susquehanna, Pa., presented the views of an electrical engineer with but recent experience in the water purification field. He thought that water plants were not kept in as cleanly condition as should be the case. He felt that painting should be more frequent with light shades used to impart the feeling of cleanliness. Important tests such as the residual chlorine test were too infrequent and should be put on a continuous and recording basis. Considering responsibilities, and comparing positions with similar ones in the electric utility field, operators' wages were much too low. A pertinent question which came to him was, why should it not be possible to evolve a test for bacterial quality of water samples which would reveal results more promptly than at present.

J. E. Brunner, Manager, Middletown Water Co.

R. H. Crone, Supt. Filtration, Susquehanna, Pa.

J. C. GRIFFITHS, Superintendent, New Kensington (Pa.) Water Company, reported that they had been troubled with bacterial growths and tadpole breeding in service reservoirs. Residual chlorine could not be held in the service reservoir (floating on the system) until ammonia-chlorine treatment had been introduced. The bacterial condition had been corrected and tadpole breeding had been apparently stopped by the process.

E. K. GRUBB, Superintendent of Filtration, Pottstown (Pa.) Water Company, outlined difficulties had with operating the old filter plant which had been corrected by added improvements. These included 20 minute period mechanical mixing chambers, equipped with variable speed "Heliocentric" Speed Reducers; dry feed machines filled by overhead rail and bucket system; prechlorination possible at 3 points and 5 hour coagulation basins. With such improvements the coagulant consumption had been cut 30 per cent; wash water 80 per cent less; power 25 per cent less; 65 hour filter runs were common and there were no mud-balls.

E. B. Wagner, Supt. Water Works and Sewerage, Downington, Pa.

E. L. Kershaw, Supt. Mohnsville Water Co., Shillington, Pa.

E. L. KERSHAW, Manager, Mohnsville Water Company, Shillington, Pa., related difficult experiences in locating wells that would yield satisfactory water in required volume.

P. R. LUTTON, Superintendent, Ellwood City (Pa.) Consolidated Water Company, told of eliminating tadpoles from reservoirs and services 9 days after stocking with 12-in. bass. Bass was a satisfactory fish because they were not affected by copper sulphate and chlorine in any practical amounts.

H. W. PHAROAH, Superintendent, Clymer Water Service Company, Indiana, Pa., had to deal with a water which contained mine waste, which at times carried 800 p.p.m. hardness and 50 p.p.m. iron, not to mention the aluminum. Little wonder he had trouble with color after-precipitation in the filtered water. Adjusting lime application to provide split treatment to give pH 7.2 to 7.4 for first precipitation and 8.4 to 8.8 in second precipitation (requiring 4 to 8 line adjustments on each shift at times) had given the best result. Even so, a

further increase of pH of filtered water to correct corrosion (pH 9.2) created after precipitation.

E. B. WAGNER, Superintendent, Water Department, Downingtown, Pa., said that river pollution by dye wastes had been his chief difficulty. High prechlorination had assisted coagulation and improved color removal. Tastes had been destroyed by heavy chlorination of effluent followed by two days (theoretical) storage in the distribution reservoir. To correct pH, caustic soda had been substituted for lime because the added hardness from lime application was not desired.

Dr. F. E. Hale and W. D. Collins Guest Speakers

As guest speakers, Dr. F. E. Hale, Director of Laboratories, Department of Water Supply, New York City, and W. D. Collins, Chemist in Charge, Quality of Water Division, U. S. Geological Survey, presented interesting papers.

Dr. Hale gave an account of laboratory and purification control work under his supervision. The magnitude and diversity of the work is appreciated when one realizes that the New York Department of Water Supply owns and operates a number of sewage treatment plants on its water sheds; examines upwards of 24,500 samples of water and sewage yearly and makes numerous analyses of a diversity of materials; conducts corrosion control studies and other investigations. One of the most important phases of purification is algae control and to certain reservoirs copper sulphate is applied at the inlet continuously through dry feeders. On the New York system there are 110 points of chlorination (some being operated only at intervals) and much of the surface water receives three and all of it two applications of chlorine between its source and the consumer. Dr. Hale stated that a portion of the time alum and soda ash had to be added to clarify the turbid Catskill water as it entered Kensico Reservoir. Ammonia-chlorine treatment had been used on well supplies and proved effective in holding crenothrix growths in mains under control. In other instances, chlorination had assisted materially in the control of algae whereby copper sulphate consumption had been reduced. To know the quantities of chemicals consumed, is to appreciate the magnitude of the treatment of New York's water supply. Dr. Hale reported figures for 1933 involving the use of 102 tons of copper sulphate; 870 tons of chlorine; 25 tons of bleaching powder; 3,713 tons of alum; 1,857 tons of soda ash. He added that the alum and soda ash consumption for 1934 would be considerably more than in 1933.

In control of sewage treatment the chlorinated plant effluents had registered a b. coli index of only 0.4 per hundred C.C. and experiments revealed that satisfaction of 50 per cent of the chlorine demand would reduce the coli content 90 per cent.

In chlorination control careful checks were maintained on residual chlorine—samples being taken in routine both before and after chlorine application. In the practice of split chlorination 0.1 p.p.m. residual was maintained just beyond at least one point of application. Since the chlorine demand had been so thoroughly satisfied, the distributed water must contain not more than half this quantity (0.05 p.p.m.) to avoid detection by consumers. Dr. Hale said, that soda ash had been experimentally used on a large scale with some benefit in reduction of cold water corrosion but with practically no reduction in hot water attack. The results had not been sufficient to justify the cost of treatment and studies under way involved the use of several alkalies, including lime. The finished New York City water had a b. coli index of but 0.01 per 100 C.C. in 1932 and 0.04 in 1933.

GEORGE E. TAYLOR, of Scranton, Pa., commenting on Dr. Hale's paper, pointed to the evident advantage of close control to prevent algae flare-ups—i.e., prevention rather than cure. It was evident that split chlorination had distinctive advantages whenever practical of application. That attention to details in purification (particularly chlorine control) was conducive to good operation was plainly evident from results attained by the New York authorities at the least expense for chemicals to produce a consistently satisfactory water quality. The results attained in sewage treatment were astounding—an evidence of the thoroughness of protective control of New York's unfiltered supply.

Dr. Hale, replying to questions, said that sewage plants were built, owned and operated by the Department of Water Supply at no cost whatever to the communities or institutions served except that connection to sewers was paid for by the property owners. Dependence upon self purification by storage in reservoirs had been shown to be a false premise—short-circuiting was too pronounced, even in the largest. Routine chlorine demand determinations of the water at various points of treatment were conducted to check on operation and to insure adequacy but economy in chlorine consumption.

"Chemical Characteristics of Ground Waters"—W. D. COLLINS, Chemist in Charge, Water Quality Division, U. S. Geological Survey, Washington, D. C.

W. D. Collins, U. S. Geological Survey, Washington, D. C.

Norman J. Howard, Toronto, Ont.

Mr. Collins in his customary interesting, instructive and entertaining manner discussed the important elements of water quality from a chemical and physical standpoint. He said that one advantage from ground waters was found in their relative constancy of quality and temperature. The U. S. Geological Survey had made an extended study in an endeavor to predict in advance the characteristics and yields of water at various locations and geological formations. Such predictions had considerable value to industries seeking water supply locations, and also to communities. He said that practically every water supply had some degree of shortcomings—was too hard, too soft and corrosive, and therefore needed softening or hardening. Whereas, in most waters hardness in the form of calcium salts predominated, the waters from serpentine rock formations contained but little calcium and the hardness was mostly magnesium bi-carbonate. In brines from salt wells calcium hardness predominated whereas salt water was much richer in magnesium salts. The alkalinity in certain deep well waters was largely sodium bicarbonate. This, because the hard water from upper strata had passed through natural beds of zeolite (green sands) and exchanged calcium and magnesia for sodium. Ground waters were frequently corrosive, he said, and he told of an interesting story in which copper piping

had been attacked and the dissolved copper had later deposited out completely on brass pipes in a residence—an interesting case of natural copper plating.

R. W. STONE, Assistant State Geologist of Pennsylvania, in discussion, revealed that his Department had made a practice of offering advisory service to engineers, industries, municipalities or individuals in respect to locating wells and what to expect from ground water exploitations in the areas already surveyed and studied.

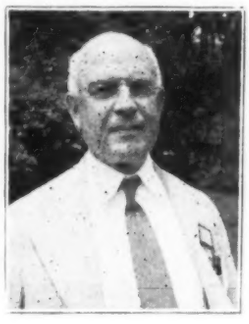
In reply to questions Mr. Collins said that he thought the organic content of waters (humius and the like) to be more important in copper attack than a low pH value. Dr. Hale felt that high CO_2 content was also responsible because the very soft Catskill surface water had not attacked copper, whereas the Garden City, L. I., well-water, containing appreciable CO_2, had done so to some extent.

NORMAN J. HOWARD, honored guest from Toronto, said that well waters did not always hold constant in quality, some having been known to suddenly change in mineral quality. Especially had this been true of iron content in his own experiences. H. M. FREEBURN cited a case of changing sanitary quality of well waters created by heavy pumping—the net result being water borne epidemics traced to sewage drawn into the water strata.

Operating Experiences at Easton, Pa.

"Operation of the New Filtration Plant at Easton, Pa."—R. W. HAYWOOD, JR., Superintendent of Filtration, Lehigh Water Company, Easton, Pa.

Harry P. Hall, Hyattsville, Md. (President 4 States Section A.W.W.A.)



Prof. E. D. Walker, Pennsylvania State College

In summing up operating experiences at the Easton plant where tastes and short filter runs from algae and mud ball formations had been a problem, along with corrosion, Mr. Haywood reported that ammonia-chlorine treatment of the raw water to cope with tastes and minute algae had not been as effective as ordinary but heavy prechlorination, with dosages as high as 4 p.p.m. at the lowest stages of the river. Increasing wash-water rates from 24 inch to a 32 to 36 inch rise had improved filter bed conditions. Adding powdered carbon to the prechlorinated water in the mixing chambers could be done without lowering residual chlorine. Raising the pH of the filtered water to between 9.0 and 9.4 seemed to increase consumer complaints of rusty water—possibly the high alkalinity having caused a loosening or disintegration of tubercules. Operating on the marble test basis, a pH of 8.0 to 8.2 was sufficient to produce a non-aggressive cold water and lime was now being applied on that basis of control. Warming the slaking water and efficient baffling of a large solution tank had been helpful in the lime application, and resulted in a saturated solution carrying only the finest particles in suspension to the clear well. The ammonia had been switched to the filter effluent and residual chlorine in the mains was gradually extending away from the plant. Instituting regular class-room meetings of filter plant operating personnel had been a valuable step in improving operations and relationships between the personnel of the force.

L. L. HEDGEPETH, Pennsylvania Salt Manufacturing Company, Philadelphia, Pa., in discussion, said that the Easton experiences placed emphasis on the need of more individual thought applied to water treatment problems. Disregard for many ideas assumed to be "law," would sometimes lead to unexpected results and reveal that many assumptions are made to be broken down in scientific progress. It was well to read what appeared to be axioms in reference works or published articles, but at the same time proceed to test their soundness or lack of suitability under newer conceptions. That "fixed" rules are made to be broken, had been the experience of many, including Mr. Haywood who, like others, had learned that a super-chlorine dosage to raw-waters in periods of taste troubles has proven superior to lighter dosages, and that pre-ammoniation may be actually detrimental rather than beneficial under such circumstances.

Methods of Evaluating Odors and Tastes

M. W. COWLES, Health Officer, Hackensack (N. J.) Water Company, another guest speaker, discussed methods of quantitatively estimating tastes and odors which had proven very helpful in the control and evaluation of treatment processes. Reported somewhat in detail in previous issues of this magazine,* to avoid repetition, the method will not be repeated here except to say that it is the procedure perfected by Professor Fair and Mr. Wells, of Harvard University, involving a modification of the dilution method of Spaulding with odor free water and the use of the "Osmoscope"—representing an improvement on the "sniffing tube" devised by Baylis.

Mr. Cowles, in reply to questions, said that smell and taste fatigue could be easily overcome by chewing "Dentyne" gum—"for which advertising he was not paid." Distilled water, he said, was no good as an odor free diluting material. Instead, he recommended procuring water from a well or spring and passing it through granulated carbon. The osmoscope was now being produced by Eimer and Amend of New York.

B. F. JOHNSON, Chemist, New Castle (Pa.) Water Company, considered the improved method practical and

*See WATER WORKS AND SEWERAGE, Oct. 1933, p. 360; Apr. 1934, p. 123; July 1934, p. 254.

Snapped on the Campus at State College

time saving. Sniffing camphor aided the fatigued observers in his laboratories and he had continued to follow the practice of concentrating odors and tastes in distillate from large samples of water in order to increase the ease of detection. From this innovation introduced 3 years ago in all American Water Works and Electric Company laboratories, it was plainly evident why distilled water was not a proper diluent for the test.

E. C. TRAX, Chemist, Water Works, McKeesport, Pa., said, that aside from the value of the improved method, he could foresee a new type of technician in water purification plants. The young man who would become "Chief Sniffer and Sipper of Water" would doubtlessly be one with good habits and "a pride to his mother."

Metering and Maintenance

A discussion of "Metering and Meter Maintenance" was opened by GUY W. MORROW, Division Superintendent, Penna. State Water Corporation, Washington, Pa.

CHAS. L. FOX, Assistant Superintendent, Pennsylvania Water Company, Wilkinsburg, Pa., made several interesting suggestions among which was their scheme of giving each repaired meter a new coat of aluminum paint which impressed the consumer because of its appearance as a thoroughly renovated if not a new instrument. Furthermore, the repair men took more pride in shop work in consequence. He stressed the need of giving more adequate thought to the size of meters supplied on a consumer's line, and less regard to the existing size of the service supply line, if the maximum economy and efficiency was to be expected. Standardization on one or two makes of meters was his present aim for many reasons—heretofore having had to deal with several makes at greater maintenance and stock keeping expense. Public Service Commission rulings required that ownership of meters reside with the privately owned water companies, the customer paying for damages only. The limit on time between inspection and testing of meters established by the Commission was too long, his company having found it advantageous to make more frequent tests, viz.: 7 year intervals between test of ⅝-inch meters, 6 years for ¾-inch and 5 years for 1-inch meters, instead of P.S.C. requirement of 10, 8 and 6 years respectively.

Damaged meters from hot water was the most serious cause for repairs and expense to the customer, indicating the need for a satisfactory scheme of preventing such occurrences. Frost damage was less of a problem and easily overcome by insisting on a protected location before making installations—thus preventing much ill will later by preventing expense of repairs to the customer. That metering pays goes without saying and a system using partly flat rate and partly metered was fundamentally unsound and inequitable in its treatment of customers.

Liquid Chlorine and Copper Services Stand Out in Cold Weather Emergencies

Under the caption **"The Frost"** there was considerable discussion led by D. J. MCGEEHIN, Superintendent, Wyoming Valley Water Company, Hazelton, Pa., who recited interesting and crucial experiences during the past winter with temperatures of 26 to 33 deg. below zero. Many unsuccessful attempts to keep ahead in thawing out frozen services had required laying of temporary lines (kept flowing to waste) in order that water could be obtained by residents. Thawing with portable arc-welding equipment had been the most satisfactory scheme used, but in a few instances steam had been required. The superiority of copper tubing for services had been clearly demonstrated—2,000 such services being in use without one break, whereas, lead services had no such record. Thawing operations causing dislodgement of tubercules and rust had created considerable difficulty in stoppages at curb cocks and meters.

A serious condition had developed when the chlorinated lime solutions froze up solid and no chlorination was had, until installation of an emergency chlorinator and liquid chlorine was made at 2 a. m. the night of the complete failure of the hypochlorite equipment.

RAY OWEN, of Clark Summit, Pa., had the experience of having 24,000 feet of frozen main at 5 ft. depth and thirty per cent of the services froze. Transformers (25 to 30 K.V.A.) feeding 200 to 300 amperes were used in main thawing, but not without some damage to lead substitute joints resulting.

MR. CRONE of Susquehanna, Pa., offered the suggestion that hereafter a small steel wedge be inserted in each substitute joint. This had been his practice and thawing was simplified thereby.

MR. SITES of Hydraulic Development Corporation at this stage exhibited small leaden wedges supplied by his company to place in joints made of "Hydrotite." Steel he said was also satisfactory but it was easier to prepare and use the lead wedges.

MR. KNIGHT of Natrona, Pa., reported difficulties with couplings involving the use of rubber gaskets which checked current flow and damage resulted to the rubber also.

A case was reported in which a 40 inch ice blanket on a reservoir had seriously depleted the fluid supply, already rapidly dropping due to wastage of water to prevent freezing of small mains and services.

The matter of paying for service thawing was discussed, some had split the cost with the customers—others stated that, since it cost no more to thaw to the property line from the main than to thaw the whole service, no charges had been made against the customer.

MR. TAYLOR, of Scranton, Pa., said that their chlorinators had been of insufficient capacity to meet the requirements due to heavy draught created by cold weather wasting and leaks. The severe cold had brittalized the silver chlorinator tubes and caused them to snap off and hypochlorite solutions were useless because of their freezing up.

CHAS. L. FOX, of Wilkinsburg, Pa., was the most envied superintendent at the meeting when he reported that strict regulations had saved his company much grief. All mains and service lines being not less than 4.5 feet deep there was no freezing of either. He admitted that customers objected to placing service lines so deep but "rules was rules" and this time worth-while ones.

H. E. Beckwith, Pitometer Co., Harrisburg, Pa.

Kenneth Sites, Hydraulic Development Corp., New York City

Wasted Water

"Wasted Water" was the subject of a paper by H. E. Beckwith, Engineer, The Pitometer Company, Harrisburg, Pa., who pointed out that a thief in the dark (water-waste) was 365 days and nights, in the year, robbing water companies and municipalities without doing good to anyone. On unmetered supplies it had been common to find that 25 to 50 per cent of the supply was escaping through hidden leaks. In addition to accidental leakage, waste water surveys had uncovered water steals by industrial plants through unauthorized and unknown connections to the mains.

He said that his company had located leakage amounting in the aggregate to 500 m.g.d.—a sufficient quantity to supply 5 million proper and better, representing the combined requirements of Philadelphia and Cleveland. The gross savings per year had been estimated as representing interest and amortization of an investment of $400,000,000 in plant structures required to supply the the quantity of waste located and stopped. In many instances leakage surveys had postponed the apparent need for increased supply or distribution facilities.

J. M. Crichton, Jr., Superintendent, Portage (Pa.) Water Company, reported on experience with local surveys, using a metered by-pass around closed valves and the aquaphone method. It had been partially successful, whereas a careful pitometer survey later had located many undiscovered leaks. It was now possible to keep the service reservoir filled with resultant pressures satisfactory. Mr. Crichton told of instances wherein rats had gnawed through lead service pipes and considerable leakage had thus resulted.

Topical Discussions

A series of questions to constitute open discussion on selected topics occupied an hour or so of the program. Among the points brought out were the following:

Application of copper sulphate to raw water continuously during algae season had lengthened filter runs and controlled algae in the basins. In coppering reservoirs it was a waste of effort to add too little. A few dead fish and tadpoles would be the only penalty when adding more adequate dosages. Secondary growths were to be watched for after 3 to 4 weeks following the first application.

Prechlorination had been on the whole quite valuable in filter plant operation. Before starting the practice it was best practice to clean up the filters by removing them from service (in sequence) and heavily chlorinating to remove slime from the beds, which otherwise would loosen up and pass into the effluent—often creating a foul tasting water in early stages of prechlorination. Manganese deposits on sand grains served to dechlorinate waters.

Floc in water if broken up in warm waters would collect again but not so in cold waters, even after 10 hours. Floc was also peptized if too much alkali was added. Mechanical aids and air wash served useful purposes in filter washing, especially in lime soda softening to prevent sand cementation. Air wash followed by short high velocity washes had been the most effective. Recovery of spent wash water by return to raw water was feasible and helpful to coagulation if not overdone, 1 wash water to 18 raw water had been O.K. and materially reduced operating cost. If using activated carbon a benefit would be felt in the returned carbon to the raw water.

Unless systematically planned and conducted, main flushing was more harmful than helpful. Not less than a 4 to 5 ft. per second main velocity would do the job properly; and, careful mapping out of a program first then starting nearest to the reservoir and working out on the system constituted the best practice.

EIGHTH ANNUAL CONFERENCE OF THE PENNSYLVANIA SEWAGE WORKS ASSOCIATION

At the close of the meeting of the Water Works Operators' Association the Pennsylvania Sewage Works Association held its Eighth Annual Conference at State College, Pa., on June 27th-29th, the registration being 115.

Officers named for the ensuing year are:

President—Roy L. Phillips, Meadville, Pa.

Vice-Pres.—E. B. Wagner, Downingtown, Pa.

Vice-Pres.—R. R. Cleland, State College, Pa.

Secy.-Treas—L. D. Matter, Wilkes-Barre, Pa.

Editor—J. R. Hoffert, Harrisburg, Pa.

Federation Board Members—C. A. Emerson, Jr.; H. E. Moses.

Harry J. Krum, City Chemist, Allentown, Pa. (Retiring President)

Important Actions Taken

The Association voted its cooperation and assistance to the faculty of Penna. State College in arranging an Annual Short Course for Sewage Works Operators to be held at State College early each year, starting in 1935. The Association likewise voted in favor of an Operators' Licensing Law for Pennsylvaia and the committee was instructed to draft the bill for presentation at an early session of the legislature.

A vote carried, recommending that the State Legislature consider an amendment to the Constitution which will permit municipalities to incur increased indebtedness up to 10 per cent of their assessed valuations. The purpose of such amendment is to allow the financing of needed improvements and additions to existing sewerage systems and treatment works; to make legal the financing of new works. The proposed amendment excludes all indebtedness incurred in connection with facilities financed out of charges collected in the form of sewer rentals, i.e., utility operating income.

Technical Sessions

(President, Harry J. Krum, presiding.)

The Conference was opened with an informal illustrated talk by Doctor Willem Rudolfs on "Some of the Newer Sewerage Developments Abroad."

Among the papers presented the following were of unusual interest.

Professor Gordon M. Fair, Harvard University,

discussed the life history, habits and control of the trickling filter fly which was of considerable value to operators in that he outlined various methods used to control this pest and cited the relative success obtained with each method. The Chairman, Harry J. Krum, of Allentown, Pa., and others added information of value.

ALBERT L. GENTER, Chemist and Mechanical Engineer of Baltimore, in discussing, "Elutriation and Filtration of Sewage Sludges," disclosed marked reductions in consumption of sludge conditioning chemicals which had resulted from washing sludges (elutriation) preparatory to conditioning and filtering on vacuum units. C. E. KEEFER, summarized the practical and economic advantages derived from the elutriation scheme at the Baltimore demonstration plant—particularly in connection with dewatering digested sludges.

F. W. JONES, of Clevelond, Ohio, presented a paper dealing with **"Drying of Sludge on Vacuum Filters vs. Open Drying Beds,"** which together with the discussion emphasized the undisputed place held by vacuum filters in dewatering activated sludges, and their increasing importance in handling other sludges.

Experiences with **"Sludge Digestion at Meadville"** by C. H. YOUNG, and the President Elect, Roy L. Phillips, contained data obtained from large scale experimentation on heat losses from temperature controlled digestion tanks; also, conclusions reached by them with several suggestions made, as the result of operating experiences with separate digestion plants, were set forth.

In addition, the following papers were presented: "Plant Operation" by W. L. Stevenson; "Notes on Sedimentation" by L. V. Carpenter; "Hershey Sewage Treatment Works and Its Operation" by H. N. Herr; "The Operation of the Hanover Sewage Treatment Plant and Its Sewage Ejector Stations" by C. A. Eckbert.

Leaders in discussion were H. M. Beaumont, F. B. Foote, I. M. Glace, H. J. Krum, W. Donaldson, J. R. Hoffert.

▼

Manufacturers' Exhibits to Accompany Conventions of Three Societies, at Rochester, September 23-28

The American Society of Municipal Engineers, the International Association of Public Works Officials and the New York State Association of City and Village Engineers will hold their respective annual meetings at the Seneca Hotel in Rochester, N. Y., during the week of September 23 to September 28, inclusive.

Accompanying these meetings will be two exhibits—one under the auspices of the American Society of Municipal Engineers, the other prepared by the Manufacturers' Division of the International Association of Public Works Officials. The latter display, it is understood, is restricted to members of the I. A. P. W. O.

The management of the Seneca Hotel, where both exhibits are to be held, states that both a.c. and d.c. current at 110 volts or 220 volts is available to exhibitors. Gas, steam and water are also to be had. The freight elevator has a capacity of 2,500 lbs. but heavier apparatus has been and can be brought in by a derrick if necessary. The exhibit floor is built of steel and concrete and will stand any reasonable weight. Other exhibit spaces will be available if required.

Information regarding the meeting of American Society of Municipal Engineers and the exhibit sponsored by it may be obtained from Henry L. Howe, Chairman, Arrangements Committee, 52 City Hall, Rochester, N. Y. A diagram of the exhibition floor may be obtained from Mr. Howe on request. The cost of exhibit spaces will range from $50 to $60 for the week.

Mr. Charles T. Hvass, 508 East 19th St., New York City, will furnish necessary information as to the I. A. P. W. O. exhibit.

Attendance by members of the three societies is expected to range from 300 to 500. Publicity for the congress is being handled on a national scale for both the A. M. E. and the I. A. P. W. O. and the programs for both organizations are being formulated by the Public Administration Service, 850 E. 58th St., Chicago, Ill. New letters are being sent out by this service to over 2,000 municipal engineers and officials, which, with the additional publicity carried on by the three societies, should assure an unusually large attendance.

Association Meetings Scheduled

Sept. 17-19—**Rocky Mountain Section, A. W. W. A.** Santa Fe, New Mexico. Secretary, B. V. Howe, State Board of Health, Denver, Colo.

Sept. 18-21—New England Water Works Association, Annual Convention. Hotel Statler, Boston, Mass. Secretary, Frank J. Gifford, Tremont Temple, Boston, Mass.

Sept. 19-21—**Michigan Conference on Water Purification.** State College, East Lansing, Michigan. Secretary-Treasurer, John Hepler, State Department of Health, Lansing, Mich. (Short School for Water Operators to be held 17th-19th at same location.)

Sept. 20-21—**Minnesota Section, A. W. W. A.** Duluth, Minn. Secretary-Treasurer, R. M. Finch, 414 Flour Exchange Bldg., Minneapolis, Minn.

Sept. 24-26—**Wisconsin Section, A. W. W. A.** Wausau, Wisc. Secretary, L. A. Smith, Supt. Water Department, City Hall, Madison, Wisc.

Sept. 24-27—**American Society Municipal Engineers.** Rochester, N. Y. Secretary, C. W. Sammelman, 4359 Lindell Boulevard, St. Louis, Mo.

Sept. 26-28—**International Association Public Works Officials.** Hotel Seneca, Rochester, N. Y. Secretary, A. M. Anderson, 100 No. LaSalle St., Chicago, Ill.

Oct. 2-3—**Ohio Conference on Water Purification.** Deshler Hotel, Columbus, Ohio. Secretary, Frank S. Taylor, Superintendent Water Purification, Defiance, O.

Oct. 4-5—**Ohio Conference on Sewage Treatment,** Deshler Hotel, Columbus, O. Secretary, W. B. Lockhart, Superintendent Sewage Treatment, Fostoria, O.

Oct. 5-6—**New York State Sewage Works Association.** Hotel Oneonta, Oneonta, N. Y. Secretary-Treasurer, A. S. Bedell, State Department Health, Albany, N. Y.

Oct. 15-18—Southwest Water Works Association. Hotel Hilton, Waco, Texas. Secretary, Lewis A. Quigley, Superintendent of Water Department, Fort Worth, Texas.

Oct. 24-27—**California Section, A. W. W. A.** Long Beach, Calif. Secretary, J. E. Phillips, Department Water Supply, 207 Broadway, Los Angeles, Calif.

Oct. 29-31—**Pennsylvania Water Works Association.** Haddon Hall, Atlantic City, N. J. Secretary, F. H. Snow, 507 Telegraph Bldg., Harrisburg, Pa.

Nov.—**North Carolina Section, A. W. W. A.** and **North Carolina Sewage Works Association.** Hotel Virginia Dare, Elizabeth City, N. C. Secretary-Treasurer, H. G. Baity, Dean of Engineering, University of North Carolina, Chapel Hill, N. C. (Exact date not decided.)

Nov. 8-10—**Missouri Valley Section, A. W. W. A.** Hotel Fontenelle, Omaha, Neb. Secretary, Prof. E. L. Waterman, University of Iowa, Iowa City, Ia.

A DIGEST OF PAPERS PRESENTED BEFORE THE 54TH A. W. W. A. CONVENTION

THE following constitutes a continuation of the digest of papers and discussions presented before the American Water Works Association, which held its 54th Annual Convention in New York City* June 4th-8th, 1934:

"New Questions of Law and Policy in the Making of Rates for Water Service"—W. L. RANSOM, Attorney, New York City.

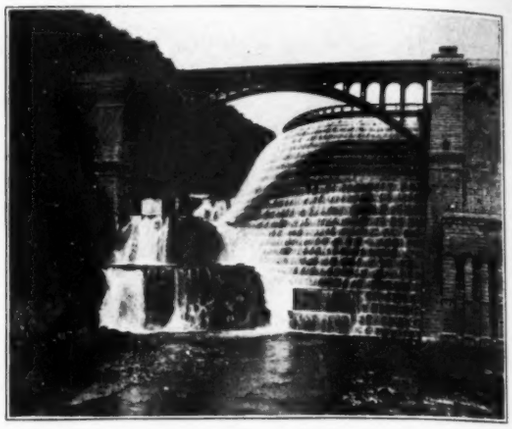
Judge Ransom pointed out that governmental intervention in the matter of financig municipally owned water works betterments was putting great regulatory powers in the hands of the federal authorities. Through Code Authorities this power was extended to reach privately owned water companies. Governmental financing meant that taxpayers were automatically becoming investors in public utilities and thereby had the right to expect municipally operated plants to become self-supporting. This, in many instances, would require upward revisions of rates. His personal opinion was that municipal rate structures should be based on those employed by privately owned utilities and that a "deal" should be given the involuntary investors (taxpayers) which was not alone new but also square. He deplored the present day tendency of Public Service Commissions to disregard opinions and figures presented by evaluation engineers and the turning back to very ancient records in making evaluations and rate making. Such practice was being used as an expedient in holding down or reducing rates. The rate of depreciation calculated seemed unfair when no added operating and replacement costs were allowed, which would be the case as a natural consequence if such depreciation was as true as pictured by the Public Service Commissions. Such actions by regulatory powers could not be accepted as a fair deal to investors in utilities and was throttling all incentive to invest capital in this important field. Judge Ransom said, that water companies required by Code to employ more men on shorter hours and higher pay, but at the same time pressed by Commissions to hold down or reduce rates, were on two horns of a dilemma. And, there was considerable need for a revision of present procedures by regulatory and Code Authorities if justice was to be realized.

"Recent Tendencies in Relation to Valuation of Water Rights"—ROBERT E. HORTON, Consulting Engineer, Vorheesville, N. Y.

Mr. Horton said that the methods of evaluating water power rights very closely paralleled those of real estate appraisal, but had to be considerably more complete. Modern tendencies were to give less weight to hydraulic power values than previously because the prevailing widespread distribution and power company tie-ins rendered less valuable some particular locations. Likewise, the combination of steam and hydraulic systems had changed the values of locations for hydraulic plants.

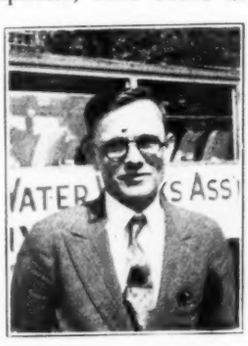
"Outstanding Factors in Underground Water Waste Surveys"—F. B. NELSON, Engineer, Department Water Supply, New York City.

Mr. Nelson related methods developed and progress made in New York City's survey work to detect leakages on the distribution system and their subsequent correction. Increased pressures on certain parts of the system had been responsible for a 70 per cent increase in leakage. The crews had used the aquaphone method as the most effective scheme of locating important leaks on small mains and all services, the stopping of which had postponed the need of additional supply by at least 3 years. Leaks on services were usually discovered by taking accurate pressure readings at the main and on the premises. From such data the volume of leakage could be determined by duplicating the pressure conditions after the repair had been made and then measuring the water being wasted in so doing. From data available, it had cost roughly $150,000 to stop the wasting of more than a million dollars' worth of water and this expense represented but a fraction of 1 per cent of the costs of providing the water saved. In consequence, the continued program of leakage surveys now under way for 4 years, by four field parties, was justified. It had paid to resurvey certain areas the third time, each survey stopping additional leakage; the cost per million gallons (of leakage stopped) being $2.30 for the first and surprisingly little more ($2.36) for the third survey.



The Lower Croton Dam, a Beauty Spot on New York City's Water Supply System.

J. B. EDDY, Engineer, Water Pipe Extensions, Chicago, Ill., in discussion, stressed the importance of employing good and constant engineering supervision and trained personnel in leakage survey work. The work in Chicago was, he said, very similar to that in New York. A regular but separate maintenance force made the actual repairs under direction of a District Superintendent. In Chicago, twelve engineering crews under experienced District Engineers were making leakage surveys at present—some of the crew having had as much as 25 years' experience. The selection of methods used in leak detection and evaluation was no less important than the experience of the opertaors. When using the aquaphone, curb cocks are closed whenever possible to



J. B. Eddy, Engineer, Water Pipe Extension, Chicago.

Fred B. Nelson, Engineer, Department of Water Supply, New York City.

*NOTE: *The 1935 Convention will be held in Cincinnati, Ohio.*

confine noises to main leaks proper—this method being the principle and most dependable one used. "The dye method" had been very successfully used on about 50 miles of mains to stop 12.5 m.g.d. of leakage which had been neither visible nor detectable with the aquaphone. Thus, the apparent need for larger mains had been cancelled by using one or both methods. In noisy areas the survey work had to be confined to night hours. Under any and all circumstances, however, leakage surveys and re-surveys had paid well during the past 18 years in Chicago.

"Thawing Frozen Mains and Services"—REEVES J. NEWSOM, Pres., Community Water Service Company, New York City.

Paul Hansen, Consulting Engineer, Chicago.

Reeves J. Newsom, President, Community Water Service Co., New York City.

Mr. Newsom discussed and summarized experiences in thawing mains and services during the extreme cold weather periods of the past winter. The most universally used equipment for thawing had been the ordinary electric welding type of portable generator sets operated by gasoline motor—two machines being connected in series for thawing the mains and single machines for house service thawing. In the latter operation safety dictated that the best practice was to disconnect the house piping system from the service line at a point just inside of the house or cellar before putting the charge on the pipe. Failure to do this had caused damage unknowingly to house wiring, sometimes setting fire to the insulation when the wiring system was grounded to the water piping.

Wherever lead substitute joints on mains had been involved, thawing was difficult unless such joints were more than 5 years old. Hot water and steam equipment had been useful when the substitute joints prevented current flow along the main or where electrical thawing proved impractical for some other reason. Such equipment had been successfully used to thaw sections of main between 75 and 150 feet long. Portable transformer sets (150 amps. at 20 volts) had also been effectively used in eelctrical thawing. The prevailing practice when using generator-welding type equipment was to use 10 to 60 volts and 200 amperes or more for service thawing. A current flow of 3 to 10 minutes had been usually sufficient on service lines and 30 minutes to 2 hours on mains. For the latter the amperage was stepped up to 400 or higher and alternating current had on the whole been more satisfactory than direct current. With substitute joints thawing took more time because the amperage had to be held between 150 and 200 to avoid danger of joint damage by arcing. Cost of thawing (per service) had been between $2.50 and $7.50. The rental on welding machines accompanied by operators had commonly been $4.00 per hour. Mr. Newsom said, there had been a considerable variation in charges made for thawing services and he thought some standardization of such charges was needed to guide water-works managers hereafter.

Mr. Newsom pointed out the great difference in resistance of steel, copper and cast iron to current flow. Since copper was 7 times a better conductor than steel, heat production when employing electric thawing could only be attained by doubling the amperage found effective with steel and applying this current about twice as long. Cast-iron being 73 times less conductive than copper would warm up more easily than any of the pipe materials commonly used.

Mr. Newsom said that the past winter's experiences should not be forgotten quickly and preparedness, with adequate thawing facilities arranged for, should be the future motto of every water-works man. Further, a standardized charge for thawing services was needed and regulations should be amended to include a thawing rate schedule before another winter.

J. A. JENSEN, Engineer of Water Works, Minneapolis, Minn., said that with temperatures as low as 30 deg. below zero, between 1500 and 2000 meters or services were frozen per year at Minneapolis. For thawing, 20 to 30 K.W. generator sets were employed and the cost per service thawed had been between $5 and $6. Regulations at Minneapolis required 8 foot depth of mains (center line) and 9 foot depth of service lines and this gave ample protection if adhered to.

Methods of Purchase of Materials and Equipment

"Direct Purchase of Materials and Equipment vs. Purchase Through Contractor"—PAUL HANSEN, Greeley and Hansen Engineers, Chicago, Ill.

Mr. Hansen named the good and the evil to be expected in making purchases of equipment and materials by the client as compared to allowing the buying to be done by the contractor. In allowing contractors to make purchases of equipment, manufacturers had complained in several instances of unfair treatment from contractors and consulting engineers. Mr. Hansen was of the opinion that on the larger projects most engineers and clients preferred to take bids on important equipment from the manufacturers direct to procure a closer relationship and single responsibility of one contractor only—the manufacturer proper. On small projects too many contractors were undesirable and the general contractor might make a greater number of purchases on such projects with benefit to all. In any event (small or large projects) the selection of important equipment, such as pumps, meters, etc., should remain in the engineer's hands after alternate bids have been procured. Contractors, naturally, prefer making purchases of all material and equipment and arranging the sequence of deliveries and installations; also, because greater net profits frequently result due to the time saved and discounts granted the contractor.

Mr. Hansen felt that no set rule could be made to fit all cases but direct purchases usually resulted in obtaining superior equipment and services. Further, it prevented "shopping" by contractors to find equipment acceptable to the engineer and client which would return the maximum profit to the contractor. He felt the subject deserved free and open discussion.

L. R. HOWSON, Alvord, Burdick and Howson, Engrs., Chicago, said that usually general contractors had not the required ability to evaluate competitive bids nor equipment offered. Competition would be sufficiently keen when taking direct bids on specification. Divided responsibility should, where possible, be avoided and it was highly important that the engineer decide on pump-

ing equipment and the like. Further, the allowance of too many alternates when bidding was frequently confusing and unduly expensive.

Round Table on Taste and Odor Control

Leader: JOHN R. BAYLIS, Chicago.

Mr. Baylis, in opening the discussion of the problems, experiences and developments in taste and odor control, laid emphasis on present day requirements of consumers which would not much longer tolerate production of a water which carried objectionable taste or odor. While

John R. Baylis, Physical Chemist, Chicago.

Alfred Eckert, Superintendent of Filtration, Saginaw, Mich.

water-works men might shy at a cost of as much as $5 to $10 per m.g. for adequate corrective treatments, that figure only represented a cost 50 to 60 cents per capita per year. This, anyone would gladly pay to be insured of receiving a water of desired quality. A cost, then, of 50 to 60 cents per m.g. for taste and odor control was insignificant compared to the evaluation of the improvement in the consumer's eyes.

GEORGE R. SPALDING, who had pioneered in the use of powdered activated carbon at the Hackensack (N. J.) Water Company's plant, related his expereinces. The procedure now in use was a continuous use of small dosages of powdered carbon to the raw-water for the purpose of keeping the coagulation basin in good condition. If and when necessary, the dosage was increased. To control algae development copper sulphate was continuously applied to the storage reservoirs and also at times to the service reservoir. Odors, he said, seemed to concentrate in the rising piping in consumers' homes during periods of low usage and it was therefore doubly necessary to remove more completely than otherwise the objectionable materials at the plant.

NORMAN J. HOWARD said, that Toronto had been the first large city (1926) to undertake systematic taste and odor control. Exhaustive experimentation had dictated the adoption of super-chlorination followed by dechlorination as the most effective and sure-fire scheme then available. The process had been in continuous use since 1928. In winter fairly high chlorine dosages had been required, because of slowness of chemical (oxidizing) action at low temperatures. As much as 35 lbs. per m.g. had been at times required with the available contact of 1 hour prior to dechlorination with sulphur dioxide. Recently, a taste had not been destroyed even with that dosage—(1.8 p.p.m. residual). Experiments had indicated that powdered carbon removed the resistant compound causing the taste.

ALFRED ECKERT related the difficult problem which he, at Saginaw, Mich., had faced when beet sugar wastes and a variety of industrial wastes from Midland, Mich., had been discharged above the Saginaw Water Softening plant. For three years he had used powdered carbon —sometimes without complete success. Split treatment, with heavy applications to the raw water and a fairly constant minor dosage to the applied water gave the best results during severe taste conditions. During the heaviest pollution period tastes were not removed completely until the industrial waste dumping was curtailed.

ARTHUR MELLEN of Minneapolis, Minn., attributed some taste and odor troubles to small plankton which were capable of getting through sand filters and thereafter decomposed in the mains. Practice adopted at Minneapolis, with the maximum benefit, had been heavy raw water prechlorination (12 to 20 lbs. per m.g.) followed by powdered carbon applied just ahead of the filters. Their experiences had indicated that old filter beds removed tastes more efficiently than new ones. To insure best results filters should be carefully watched for the first traces of turbidity appearing in the effluent—sometimes created by minute forms of plankton passing through—and washed at that point.

"Milwaukee's Water Purification Problem."—J. P. SCHWADA, City Engineer, Milwaukee, Wis.

Mr. Schwada reviewed the major developments in connection with Milwaukee's water supply, drawn from Lake Michigan and since 1910 chlorinated. From time to time tastes had been pronounced due to industrial wastes reaching the intakes.* Sludge to depths of 5 inches had been removed from the mains in certains sections of the city—greater depths from elevated tanks. For some years he and other city officials had advocated the construction of a filtration plant, but the proposal of 1921 had been defeated by factions more interested in building a gigantic sewage treatment works. More recent proposals, backed by eight different reports since 1911 recommending filtration, had also been defeated. Now, after repeated efforts, Milwaukee had under construction a 200 M.G.D. plant designed in the engineering offices of the city with Alvord, Burdick and Howson, Engineers, of Chicago, serving as consultants on the project. The plant with the most modern equipment, including "flocculators," would cost $4,600,000 and give 1,900,000 man hours of work and was being financed under contract with the PWA to accept water revenue bonds as security. The estimated operating cost would be $4.75 per m.g. at an output of 85 M.G.D. The cost of purification would represent a 10 to 12 per cent addition to the total annual bill of the consumer. As little as a 7 cent addition to the monthly bills of 92 per cent of the consumers would result. Only by persistent and repeated campaigns put on to educate Milwaukee citizens, said Mr. Schwada, was the vote of the people to build such a plant eventually gotten.

JOHN R. BAYLIS said that Mr. Schwada deserved high credit for his persistent fight for a better quality of water for Milwaukee; that he realized his difficulty when the supply had been objectionable to the consumer only at intervals. The very small additional cost for a purer water was worthy of comment. He added if water was purchasable on a basis of quality we would be surprised to learn what the majority of consumers would be agreeable to pay for the most satisfactory grades in preference to the cheaper supply. In other words, Mr. Baylis intimated that the thought of considering costs of water production ahead of quality of product was not based on sound reasoning and that the future will see better water served at increased costs but higher appreciation of the consumer.

"Telemetering—The Electrical Transmission of Gage and Meter Readings"—P. S. WILSON, Consulting Engineer, Glen Ridge, New Jersey.

Mr. Wilson described and gave the features of the four types of telemetering equipment of interest to water works men. As the word signified, telemetering

*It was at Milwaukee that foul tastes of a non-chlorinous nature in chlorinated waters were for the first time traced to a combination of chlorine with traces of phenolic bodies, entering the water in the form of industrial wastes, producing chlorphenols.—Editor.

P. S. Wilson, Consulting Engineer, Glen Ridge, N. J.

D. J. Purdie, District Manager, Builders Iron Foundry, New York City.

John Winder, Superintendent of Water Works & Sewerage, Dallas, Texas.

Walter A. Peirce, Racine, Wis. A. W. W. A. Director.

was the process of transmitting measurements over wires the point of recording being long or short distances from the point of measurement, thereby offering a considerable convenience. Telemetering, he said, was relatively new but had made rapid strides in applicability during the 10 years since its introduction. Telemetering was now being used to dependably transmit to central stations such information as water elevations in tanks or reservoirs, pressures at important points on systems, pump operations, water flows in and out of reservoirs or into a system. In filtration plants many operations could be made visible and recorded at one central point of control by use of telemetering.

The four types analyzed were the "step by step"; the "induction"; the "time-impulse"; the "current-voltage" types. The first (and earliest) type was actuated by each step of increase or decrease, such as the rise and fall of water level, which closed an electric circuit—the change being transmitted to the receiving instrument over the wire. The "induction" type operated on an induced current and armature movement. It required two wires and a ground but three wires were preferable. An advantage was that electric power was required only at one end of the system.

The "time-impulse" type operated with the automatic opening and closing of the electric circuit every minute; required a telechron clock and 110 volt A. C. current; had the advantage that there was no limit to distance of transmission. Only one wire and a ground circuit was required. The "current voltage" type was briefly explained but had, he said, a very limited use in the water works field. Mr. Wilson, by aid of slides, gave a very clear description (impossible to report adequately) of the operation of the several types of telemetering equipment.

Westford Cutler, Wallace and Tiernan Company, Newark, New Jersey, who has had considerable experience with telemetering in remote and automatic chlorinator control, said that the "time-impulse" type of equipment (as represented by the "Chronoflo") stood fair to become the most widely used because it was simple and not subject to interferences. Over the wires current could be sent in either or both directions between the widely separated instruments (stations) and this advantage allowed the operation of synchronous A. C. motors.

D. J. Purdie, District Manager, Builders Iron Foundry, New York City, described the "Chronoflo" and explained its operation with the aid of slides. The advantage of requiring but a single wire was stressed as was the fact that several transmitters could be served by it at one time. Standard equipment was geared to indicate every 15 seconds; for special conditions more frequently. The power consumption was negligible—that of a 40 watt electric bulb.

F. A. Heine, of Reading, Pa., cited advantages from telemetering which he had experienced with an installation recording reservoir elevations by 0.2 ft. changes over a 50 foot range.

A representative of the American Telephone and Telegraph Company explained the system of leasing telephone wires for use with telemetering equipment and Mr. Stewart of the General Electric Company told of the great importance of telemetering in the power field.

A Pumping Station That Talks Over the Phone

Leon Small, Engineer of Water Supply, Baltimore, Md., described Baltimore's novel automatic booster pump stations—two of which were, figuratively speaking, able to "talk" over the telephone and by code signals reveal prevailing conditions of pumps, motors and valves, pressure conditions and elevation of water in elevated tank or reservoir. The advantages of the automatic station operation and reporting lie in the fact that operators at the stations were not required and from any point on the telephone system the station phone could be called and in a few minutes conditions prevailing would be signalled, thus securing a report without making a long trip to these outlying stations.

Mr. Small had a loud-speaker attached to the telephone connection within the hall and demonstrated the automatic reporting by calling the Baltimore telephone operator and giving the station telephone number in the ordinary manner. He explained that the station call would lift the telephone receiver hook and thereafter in succession came the long and short code buzzes which revealed in succession, by comparison with a large chart (a) condition of the electric circuit, (b) what pump or pumps were in operation, (c) the discharge pressure, (d) elevation of water in the reservoir, (e) direction of flow—into or out of the reservoir or tank. He then telephoned an attendant (at the station for the purpose) to upset the station in a manner that an electrical storm might do. Following this, the station was again called and the automatic code reporting revealed the new conditions and where the trouble existed. If a true condition, the Division Superintendent, receiving the report, would proceed to the station with a knowledge of conditions before arrival and therefore prepared for the correction. The only routine visits to these stations were those for the purpose of oiling and checking up. The cost for telephone service was only that of an ordinary telephone installation. The stations, he said, were called frequently during electrical storms, when to learn that conditions were O. K. was a deal of satisfaction and an anxiety reliever.

(*Adjournment*)

EDITORIALS

On Selling Water Softening

Only during the past 10 years of its century of availability has water softening been extended in the municipal field to any appreciable degree. Even so, a remarkably low number (approximately 1 per cent) of the more than 10,000 American municipal supplies are now being softened.

If one examines maps prepared by the U. S. Geological Survey, picturing the United States divided into zones making use of waters of the several indicated ranges of hardness, the natural question arises: Why have these millions of people been content to continue with the use of hard water these many years? Perhaps the only true explanation is found in the fact that these people, lacking in experience with other than hard waters, are yet ignorant of the advantages of softened water. Many believe still that softening ruins the taste and healthfulness of the "God-given" product on which their grandfathers pioneered and lived to be 90 or older.

Whatever the explanation may be, it would seem that this enlightenment as to the value and healthfulness of softened water to the community (plumbers and soap merchants excepted), has been neglected. In this era of Trade Associations and Institutes, promoting this or that material or process, it seems strange that the fertile field of municipal water softening has until now been neglected to the extent it has. A useful, constructive and remunerative work lies in store for a new organization—"The Soft Water Institute"—or whatever may be its correct name. This organization can do much to clarify confusion in the minds of municipal authorities and engineers as to the technical truths concerning claims of various water softening interests in the field. It can stabilize an industry with so important water supply services to offer.

As an illustration of the need and value of a little education of the public in the economy of water softening; and, if possible, giving the community just a little sample of its worth to it by store window demonstrations or other means, see what was said in an editorial which appeared recently in the *Kent* (Ohio) *Tribune*, under the caption, "Bring Back the Water Softener."

> "You never miss the water 'till the well runs dry . . ."
>
> By the same token Kent housewives never missed the water softener until Waterworks Superintendent Ollie Young closed it down for repairs several days ago. Housewives who haven't bought water softeners (chemicals) for washing clothes since Kent installed the softener back in November, 1930, were storming into stores this week with blood in their eyes. Once pure white sheets wore a disgraceful cloak of iron rust today, mute testimony that something was wrong with the water.
>
> "Telephone calls have been pouring into the office of Superintendent Young, eagerly inquiring when the softener will be again operating. Persons once skeptical about whether or not Kent could justify an investment of $29,000 in a water softening plant seem to have been converted.
>
> "Let's hurry and get that softening plant back in action!"

The final paragraph pertaining to converted skeptics is a whole story in itself.

Without question, there has been more laundry work done by housewives at home and less sent to laundries during the past three years than for some time previously. It seems certain that if the survey made by Buswell and Hudson (reported in the Journal of the A. W. W. A. for June, 1932), to show the volume and value of soap and softening chemicals purchased from local merchants in cities served with hard water, had been repeated in 1933 surprising increases would have appeared on their data sheets. With this in mind the local "Women's Voters' League" (for lack of better title) could very likely be quickly sold in this year of 1934 on the idea of aiding in a campaign (getting votes) for a municipal water softening plant.

It would seem that by promoting softening projects water works men, municipal and state authorities, consulting engineers, manufacturers of equipment and chemicals, all, have an opportunity to do an economic service to communities, with resulting professional satisfaction or remunerative return. There is ample ammunition available for the needed campaigns.

With available water softening processes so much improved in recent years, there are methods and degrees of treatment to suit every municipal pocketbook. For the smallest communities, zeolite pressure type softeners, automatic or nearly so in operation, can now be had to eliminate the argument of the cost of manual attendance at softening plants and wastage of salt. Then, too, improved zeolites render practicable the use of smaller units, at higher rates, with less initial investment than formerly required. Further, the economies in salt consumption and wash-water requirements have been materially increased, rendering the zeolite process more attractive than ever before. For the larger plants, a combination of coagulation with partial lime softening, and the zeolite process added, seems most attractive—technically and economically.

Possibly what has most retarded a healthy growth of the technically sound process of zeolite softening, in the municipal field, has been the claims made by advocates of natural zeolites and the manufacturers of artificial zeolites, which tend to conflict. There is, according to C. P. Hoover, A. S. Behrman, whose article appears elsewhere in this issue, and other authorities, a place for both. Progress demands that this be properly acknowledged and accepted by zeolite interests, if professional intelligence is not to be insulted by presentations of biased claims and arguments. A Water Softening Institute can perform a valuable work through its technical, regulatory and promotional endeavors. It must, however, have the genuine support of the water softening interests and the respect of the water-works profession.

NEW EQUIPMENT AND LITERATURE

Stewart Fences

The Stewart Iron Works Company of Cincinnati, O.—for a half century builders of fences for all purposes—have just issued two new catalogs illustrating and describing "Stewart Fences for Every Purpose." One (No. 76) is devoted to their iron picket fences; the other (No. 75) to chain link wire fences so much used to enclose waterworks and sewerage properties—especially treatment plants.

Features—Copper Bearing Steel; Oval-Back I-Beam Posts and Rails

Exclusive features of the Stewart fence include open section I-beam construction of all posts and rails throughout. To add strength and improve appearance the special Stewart oval-back section I-beam is used as pictured above. Post extension arms, where specified, are integral with the post—another practical feature. The chain link fabric fencing and posts are made from the best galvanized corrosion resistant, copper bearing open-hearth steel—the fencing being zinc coated by a hot dip process—applied *after* fabrication. The open section framework eliminates the use of bolts, bands, tension bars and tubular parts to rust and cause trouble. The Stewart method of passing the fabric spirals through slots in terminal posts is ingenious and provides a bearing at every 3 inches, evenly distributing all strain.

In addition to fencing, the new catalog illustrates porch, balcony and stair railings; window and door grilles; flag poles, bronze tablets, ornamental lanterns, gates and miscellaneous iron work.

Write for Catalogs 75 and 76. Address Stewart Iron Works Company, Cincinnati, O.

Chicago Screenings Comminutor

A unique combination sewage screen and shredder, known as the Chicago Comminutor, offered by the Lakeside Engineering Corporation of Chicago, is attracting considerable attention in the sewage disposal field.

The Comminutor consists of a stand, on top of which is mounted a geared motor which rotates a hollow slotted cylindrical, drum-like casting on the lower end of a vertical shaft. The slotted casting, with the top end closed and lower end open, is made to rotate between 20 and 40 r.p.m., depending upon the diameter of the drum. According to the results of field tests, for small flows ¼ to ⅜ inch slots are desirable, and for larger flows ⅜ to ½ inch slots seem to best serve the purpose. A hardened steel comb is attached to the stand in such a manner that this comb will keep the slots in the screen drum continuously open as long as it rotates. The direction of liquid flow is from the outside and down through the open end of the drum and the unit is therefore useful in many screening operations without attention being required.

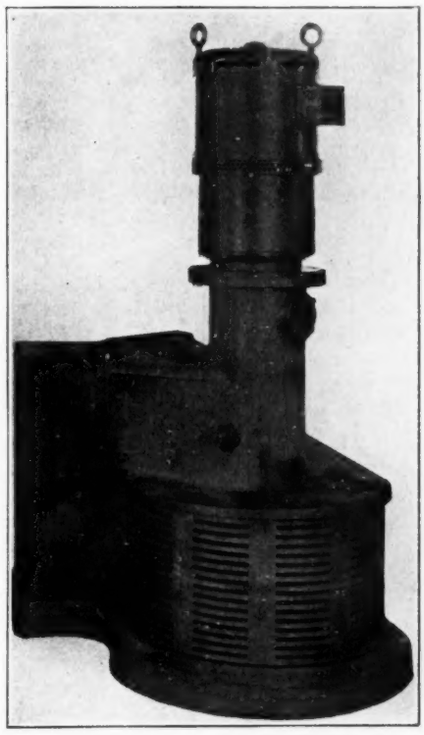
This machine was first known as the "Speed-Screen." In order to convert it to a cutting screen (comminutor), small "stellite" alloy cutters have been countersunk into the edges of the drum rings. As the basket rotates, these small cutters pass through recesses in the comb and a shearing action is produced. Golf balls, wire nails—and their equal—are rapidly chipped away. The cutters are easily removable for replacement or sharpening by simply taking out one undersized screw which holds the cutter in place.

Comminutors are built in capacities to handle (pass) up to 40,000,000 gallons of crude sewage each 24 hours. These units operate in the line of flow, without removing the sewage solids; thus, odors, unsightliness and laborious operation of screen chambers are eliminated. They are built for outdoor service which eliminates the necessity of erecting a building over the screen chamber.

These machines do not cause an increase in floating material as some would believe because the solids are not pulped. Finely cut (comminuted) screenings settle readily and seem to improve settling tank efficiencies. Comminutors take the place of screens at sewage plants and literally chew up the sizeable floating or settleable solids to produce sludge instead of odorous, fly and rat attracting screenings which must be incinerated or buried.

The comminutor, without cutters, makes an excellent apparatus for fine screening at domestic or industrial water intakes. The "Speed-Screen" is automatically kept clean and free and can be placed at inaccessible water intakes.

The illustration (above) was made from a shop photograph of one of two units to be installed at the new sewage treatment plant at Durham, N. C. (W. M. Piatt, engineer). The rotating screen drums are 25 in. in diameter and are driven by 5 hp. (1800 r.p.m.) motors.



Chicago Comminutor, 25-in. Drum

For additional information and list of successful installatons, write the Lakeside Engineering Corporation, 176 W. Adams St., Chicago, Ill., requesting their bulletin "The Chicago Comminutor"—copies of which may be procured from this office also.

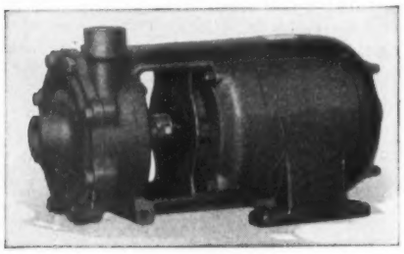
"Isco" Hand Book on Ferric Chloride

The growing interest in and expanding use of ferric-chloride in the water works and sewerage field renders timely the informative brochure just issued for free distribution by Innis, Speiden and Company of New York City, manufacturers of ferric chloride and chlorinated lime.

"Handy Information on Ferric Chloride" sets forth in a foreword; "The practices described are the result of every-day experience in the handling and use of ferric-chloride and the technical data incorporated has been collected from the most reliable sources." Such things as the specification and characteristics of commercial lump ferric-chloride and ferric-chloride solutions are given. Useful advice and information pertaining to its shipment, storage and handling is set forth and storage and solution feed-tank construction is discussed. Methods of dissolving lump ferric-chloride and procedures for making analyses will also prove useful information. Curves and tables complete the brochure. To secure a copy costs nothing more than the postage to carry a request to Innis, Speiden & Company, 117 Liberty St., New York City.

Worthington Monobloc Pumps

A late development by the Worthington Pump and Machinery Corp., Harrison, N. J., is the compact "Monobloc" Centrifugal Pumping Unit. There are several types for a variety of conditions. The most recent is a two-stage pump of high efficiency and low power requirement, intended for services where small capacity and medium discharge head are involved. The unique impeller is in effect two enclosed type impellers cast back to back, reducing overhung weight to that of a single-stage pump. The "Monobloc" is of the simplest construction with the minimum number of parts, viz., casing, impeller and motor—no more than a single



Monobloc Centrifugal Pump Unit

stage unit would have. The unit may be installed in any desired position, vertical or horizontal, and thereby becomes a valuable self-contained bit of plant equipment.

For additional information address Worthington Pump Corporation, Harrison, N. J.

▼

"Sani-Tite" Sewer Jointing Compound

Hydraulic Development Corporation of 50 Church St., New York City—producers of "Hydro-Tite" joint compound for water mains—has issued a new booklet descriptive of their joint making equipment and a sewer joint compound "Sani-Tite." The booklet discusses the value of "Sani-Tite"—the acid and alkali resistant asphalt base jointing material for eliminating breakage, infiltration and tree roots, and its ease of use in wet or dry trenches. It carries suggested specifications for use in purchasing of jointing compounds and brief instructons covering their use. Reference tables give weights of calking jute and "Sani-Tite" per joint of various sizes and style of sewer pipe.

Copies of this booklet will gladly be sent by Hydraulic Development Corpn., 50 Church St., New York City.

▼

"Packings," by Johns-Manville

Johns-Manville has just published a new, interesting and excellently illustrated catalog on their complete line of more than 60 different types of packings.

Among the new materials is the recent development in braided packing, known as interlocked braided asbestos. In making this material each individual strand of yarn is interlocked to form an integral structure, patterned after the structure of ropes used in mountain climbing.

The catalog of 48 pages includes a complete table of recommendations showing the type of packing best suited for each requirement. A section—"How to Get the Best Results from Packings" is devoted to a discussion of methods of installing packings and the factors upon which satisfactory results mainly depend.

Every user of packings should have a copy. Johns-Manville, 22 E. 40th St., New York City, invites you to write them (or any J.-M. branch office) requesting one.

▼

Two New Worthington Catalog Supplements

Worthington Pump and Machinery Corporation has just issued two new Catalog Supplements.

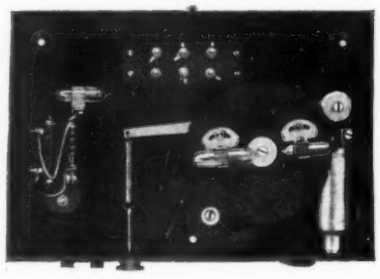
Worthington Diesel Engines—Describes the direct injection vertical four-cycle Diesel (25 to 1000 hp.) listing 31 salient features including the allowable continuous operation at full load. Can be converted for operation with natural, artificial or sewage sludge gas.

Worthington Centrifugal Pumps—Describes types C, CA and CB end section, volute casing pumps with end suction and open type impellers of cast iron or bronze.

▼

Water Level "Roto-Trol"

The Type "A" ROTO-TROL was designed particularly for the automatic control of water levels in elevated tanks, and it can be readily adjusted on the job to meet a wide variety of operating conditions. It has an electric surge-snubbing device which locks the starter in both the start and stop positions, and prevents the pump from cutting in and out in rapid succession owing to starting and stopping surges. This electric snubber eliminates the necessity for surge tanks and other auxiliary devices. The principles of the



Type "A" Roto-Trol (Cover removed. Cover hinged at bottom and has circular window in front of disc.)

ROTO-TROL are those of the springless scale, and it is therefore sensitive and accurate.

This instrument can be readily set for practically any desired water level differentials as the high level setting and the low level setting are controlled by separate mercury switches on the ROTO-TROL disc. Either the high or the low level setting can be raised or lowered by adjusting the proper mercury switch on the ROTO-TROL disc, and the adjustment of one level setting does not change the adjustment of the other. There is also a thumbscrew adjustment for raising or lowering the high to low water level in the tank without changing the differential itself. The ROTO-TROL disc has a capacity of several mercury switches, and it can be readily utilized to operate a second or third pump or high and low water alarms or signals. Complete information is contained in Bulletin R-2, which will be sent upon request addressed to Water Level Controls Co., 764 Hampden Ave., St. Paul, Minn.

▼

WITH THE MANUFACTURERS

Sanitary Division of Nichols Engineering and Research Corp.

C. F. Wertz, Sanitary Engineer of the Nichols Engineering and Research Corporation, who has been introducing the Nichols-Herreshoff sludge drier and incinerator into the sewerage field, has closed his Chicago office at 209 Jackson boulevard. Mr. Wertz will hereafter be established at the New York offices of the company at 40 Wall St., from which more intensive attention will be given introduction of this unique incinerator which is an adaptation of the Herreshoff furnace used successfully in the metallurgical field for roasting ovens and cindering. The Nichols Corporation were the successful bidders on the Dearborn, Mich., project involving incineration of sludge, grit and screenings from chemically precipitated sewages.

▼

Guy Northrop Heads Manufacturers' Association

During the New York convention of the American Water Works Association, the Water Works Manufacturers Association elected Guy C. Northrop of Hydraulic Development Corporation (New York City) as its president.

Mr. Northrop has for several years served as chairman of the committee on exhibits for the American and the New England Water Works Associations and is highly deserving of this expression of appreciation of his services to the Association.

Guy Northrop

HYDRO-TITE

means water tight water pipe joints

because it is

Self-Caulking

Hydro-Tite does not shrink after pouring; therefore it needs no caulking. It solidifies immediately upon contact with the metal and bonds both surfaces to the full depth of the joint.

Self-Sealing

"Less leakage at the start and quicker sealing to absolute tightness." A claim that has been proven in many field tests. Let us prove it to you.

Flexible

Vibration or shifting of the pipe will not affect Hydro-Tite joints . . . *permanently* tight joints even under the most severe service conditions.

"In service more than 22 years without a failure anywhere"

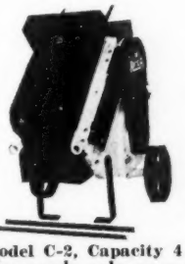
Send for Hydro-Tite Data Book

HYDRAULIC DEVELOPMENT CORP.

MAIN SALES OFFICE
52 CHURCH ST., NEW YORK, N. Y.
General Offices and Works
West Medford Sta., Boston, Mass.

SELL--THE--SLUDGE

Profits can be made, using a Royer Sludge Disintegrator



(Motor-driven Model C-2, Capacity 4 cu. yds. 1 hr.)
to break up sludge for ready sale as a compost or manure to be used on lawns and gardens.

BEFORE AFTER

Fortifying chemicals may be readily added during grinding. Belt drive and gasoline engine drive types in stock. Write for copy of paper "Value of Sludge as a Fertilizer."

Manufactured by

ROYER FOUNDRY & MACH. CO.

KINGSTON STATION
WILKES-BARRE, PA.
Write for details.
C. G. WIGLEY, Sole Rep.
3108 Atlantic Ave. Atlantic City, N. J.

Dominant FOR 17 YEARS

CHLORINE • AMMONIA

FERRIC CHLORIDE

NRA

GREAT WESTERN ELECTRO-CHEMICAL CO.

9 MAIN STREET, SAN FRANCISCO
PLANT: PITTSBURG, CALIFORNIA
4151 BANDINI BLVD., LOS ANGELES

DIRECTORY OF ENGINEERS

Aerial Mapping Since 1922

ABRAMS AERIAL SURVEY CORP.

Contractor to Federal, State, County and Municipal Government Depts., Large Corporations—Private and Industrial Interests

WE HAVE MAPPED FROM THE AIR 61 MUNICIPALITIES
AN ENGINEERING SERVICE CONTINUED AERIAL SURVEY MAPS
Highways, Transmission Lines, Pipe Lines, City Zoning and Tax Maps, Timber Cruises.

Send for our Folder—"The Third Dimension in Aerial Photography"

Submit Projects for Contract Prices — Lansing, Michigan

Alvord, Burdick & Howson

Engineers

John W. Alvord, Charles B. Burdick, Louis R. Howson, Donald H. Maxwell.
Water Works, Water Purification, Flood Relief, Sewerage, Sewage Disposal, Drainage, Appraisals, Power Generation.
Civic Opera Building, Chicago.

C. M. Baker

Consulting Engineer

Specializing in Industrial Waste Utilization and Stream Pollution Problems.
Investigations, Reports, Estimates.
2 So. Carroll St.,
Madison, Wis.

Black & Veatch

Consulting Engineers

Sewerage, Sewage Disposal, Water Supply, Water Purification, Electric Lighting, Power Plants, Valuations, Special Investigations, Reports and Laboratory.
E. B. Black, N. T. Veatch, Jr.
Mutual Bldg.,
Kansas City, Mo.

Burns & McDonnell Engineering Co.

McDonnell-Smith-Baldwin-Lambert

Consulting Engineers

Waterworks Sewerage
Lighting Appraisals
Rate Investigations
Kansas City, Mo., 107 W Linwood Blvd.
Western Pacific Bldg., Los Angeles, Cal.
Dixie Terminal Bldg., Cincinnati, Ohio.

The J. N. Chester Engrs.

J. N. Chester
J. F. La Boon
D. E. Davis
J. T. Campbell
E. B. Bankson

Consulting Hydraulic, Sanitary and Valuation Engineers.
Clark Bldg., Pittsburgh, Pa.

Chicago Testing Laboratory, Inc.

and affiliated

Chicago Paving Laboratory, Inc.

Consulting and Inspecting Engineers

Hugh W. Skidmore
Gene Abson
Materials, Processes, Structures, Consultation, Inspection, Testing, Design, Research, Investigation and Experts in Litigation.
536 Lake Shore Drive, Chicago.

H. Burdett Cleveland

Consulting Sanitary Engineer

Water Supply and Purification, Sewerage and Sewage Disposal, Refuse Disposal, Treatment of Industrial Wastes, Design, Reports, Consultation, Investigation, Evaluation of Works, Supervision of Construction.
90 Wall St.,
New York City.

G. Gale Dixon

Consulting Engineer

Water Works—Sewerage.
Home Savings and Loan Bldg.,
Youngstown, Ohio.

Fowler, Charles Evan

Consulting Civil Engineer

M. I. Am. C. E.
M. Eng. Inst., Can.
BRIDGES AND ARTISTIC STRUCTURES.
FINANCING FOR GOOD PROJECTS.
5 West 63rd St., New York.

Fuller & McClintock

Engineers

George W. Fuller
F. G. Cunningham
C. A. Emerson, Jr.
Elmer G. Manahan
W. Donaldson
Ernest W. Whitlock
H. K. Gatley

Water Supply, Water Purification, Sewerage, Sewage Disposal, Garbage and Industrial Wastes Problems, Valuations and Rate Investigations.
New York, 11 Park Place

Nicholas S. Hill, Jr.

Consulting Engineer

Water Supply, Sewage Disposal, Hydraulic Developments, Reports, Investigations, Valuations, Rates, Design, Construction, Operation, Management, Chemical and Biological Laboratories.
112 East 19th St., New York.

A. Elliott Kimberly

Consulting Sanitary Engineer

Water Supply, Water Purification, Water Softening, Sewerage, Sewage Disposal, Sewage Treatment, Waste Treatment. Specialists in Milk and in Canning Waste Treatment.
568 East Broad St., Columbus, Ohio.

Morris Knowles, Inc.

Engineers

Water Supply and Purification, Sewerage and Sewage Disposal, Valuations, Laboratory, City Planning.
Pittsburgh, Pa.

Metcalf & Eddy

Engineers

Water, Sewage, Drainage, Refuse and Industrial Wastes Problems, Laboratory, Valuations.
Statler Bldg., Boston.

Malcolm Pirnie

Engineer

Water Supply, Treatment, Sewerage Reports, Plans, Estimates.
Supervision and Operation.
Valuation and Rates.
25 W. 43rd St., New York, N. Y.

Potter, Alexander, C. E.

Hydraulic Engineer and Sanitary Expert

Sewerage and Sewage Disposal, Water Supply and Purification.
50 Church St., New York.

Sheppard T. Powell

Chemical Engineer

Treatment of Water for Industrial Uses.
Trade Waste Investigations and Correction.
Technical Expert in Litigations.
330 N. Charles St.,
Baltimore, Maryland.

Astrid S. Rosing, Inc.

Sewer Pipe.
Drain Tile.
Steam and Electric Conduits.
Building Tile.
Fire Brick.
2417 Orchard St.,
Chicago, Ill.

P. H. Taylor Audit Co.

Municipal Accountants and Auditors

Audits.
Systems.
Budget Preparation.
Investigations.
267 Highland Ave., Buffalo, N. Y.

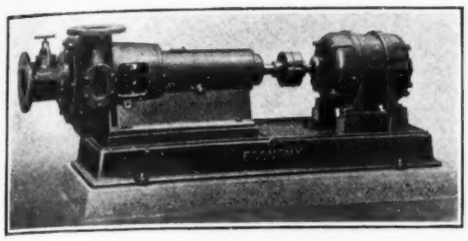
Whitman & Howard

Engineers

(Est. 1869—Inc. 1924)
Channing Howard
Walter A. Janvrin
Paul F. Howard
C. Roger Pearson
Harry W. Clark, Associate
Water Supply, Water Purification, Sewerage, Sewage Disposal, Water Front Improvements and all Municipal and Industrial Development Problems. Investigations, Reports, Designs, Supervision, Valuations.
89 Broad St. Boston, Mass.

P. S. Wilson

Consultant in Sanitary and Hydraulic Engineering.
Water Works Management.
Glen Ridge, N. J.



Horizontal Sewage Pump
Easily Accessible Suction and Case Cleanouts
Capacities up to 10,000 G.P.M.
Ask for Bulletin No. 429

SEWAGE PUMPS

Economy Sewage Pumps are built in a variety of types for any application.
The wide range of sizes enables *efficient* selection to meet every operating condition.
Economy Engineers will be glad to help you.

ECONOMY PUMPING MACHINERY COMPANY
3431 West 48th Place Chicago, Ill.
Consult Telephone Directory for Representatives in Principal Cities

Economy Pumps

The PHIPPS & BIRD SOLUTION FEEDER

embodies a number of most desirable features:

1. Accuracy
2. Simplicity of Operation
3. It will feed the most corrosive liquids
4. Initial cost is low
5. Practically no cost of maintenance
6. Adaptation to almost any condition

Write us, giving your conditions.

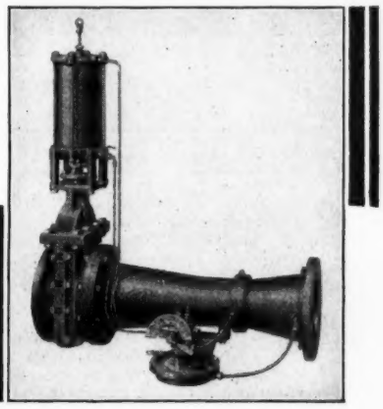
PHIPPS & BIRD, INC.
915 EAST CARY STREET
RICHMOND, VIRGINIA

Type CD Rate of Flow Controller

Accurate
•
Sensitive

INFILCO PRODUCTS

Aerators
Automatic Boiler Blowdown
Basin Level Controllers
Chemical Proportioners
Clarifiers
Coagulant Feeders
Dechlorinators
Depth Gauges
Directional Flow Controllers
Disk Filters
Dry Chemical Feeders
Filtration Plants
Filter Underdrains
Flow Indicators
Gravity Filters
Hot-Flow Water Softeners
Hydraulic Valve Controls
Hydrodarco Purifiers
Iron Removal Plants
Loss of Head Gauges
Lime-Soda Water Softeners
Lime Slakers and Feeders
Manometers
Orifice Feed Boxes
Oil Removal Filters
Proportioning Equipment
Pressure Filters
Recarbonating Equipment
Rate of Flow Controllers and Gauges
Sampling Tables
Solenoid Operated 4-Way Valves
Steam and Gas Purifiers
Strainers and Distributing Nozzles
Swimming Pool Filters and Equipment
Sterilizers
Taste and Odor Removal Plants
Venturi Tubes and Infilco Meters
Water Stills
Wet Chemical Feeders
Zeolite Water Softeners



THE only duty of the diaphragm is to move the small CD balance weight and the light control pilot, both of which are inside the casing. Power for moving the control valve is obtained from an outside source so that the measuring efficiency of the venturi tube is not impaired. Stuffing box and pivot friction is eliminated. As a result—the Infilco Type CD Rate of Flow Controller is exceptionally accurate and sensitive throughout its operating range.

SEND FOR BULLETIN 67

International Filter Co.
Water Softening and Filtration Plants
General Offices
59 East Van Buren Street, Chicago

INTERNATIONAL

The new HELLIGE TURBIDIMETER

Eliminates the preparation and use of standard suspensions—Utmost convenience—Highest accuracy. If connected to the water line, the apparatus permits a continuous check of the turbidity without the necessity of refilling tubes with individual samples.

Reads all turbidities down to zero-turbid water.

Bulletin No. 8000 contains detailed information.

HELLIGE
INCORPORATED
179 EAST 87TH STREET, NEW YORK, N.Y.

LOCAL WORK for MORE LOCAL WORKERS

LOCAL labor is not only used for the laying but also for the manufacturing of Lock Joint Pressure Pipe, thus greatly relieving the local unemployment problem.
Lock Joint Pipe Co. Est. 1905. Ampere, N. J.

LOCK JOINT REINFORCED CONCRETE PIPE
PRESSURE - SEWER - CULVERT

CALDWELL'S "PIPEFINDR"
Locates and Shows
Depth of Pipe
Sent on 30 Days' Trial
GEO. A. CALDWELL CO.
27 EDGEWATER DRIVE BOSTON, MASS.

EDSON'S NEW HAND PUMP
Smallest Diaphram Pump Made. 2" Suction Open Discharge. Capacity 1400 G.P.H. Weight 50 lbs.
THE EDSON CORP'N, 49 "D" Street
So. Boston, Mass.
NEW YORK: 142 Ashland Pl., Brooklyn
CHICAGO: 3500 N. Long Ave.
Catalog "T" Gives Full Data, Also Edson Hand and Power Pumps, Suction Hose and Pump Accessories

Use LAMOTTE EQUIPMENT *for*
pH Control—Residual Chlorine Control
Boiler Feed Water Control
LAMOTTE CHEMICAL PRODUCTS CO.
442 Light Street, Baltimore, Md.

WYCKOFF REDWOOD PIPE
Lasts long and saves money. This is our new type all clear California Redwood Pipe of highest quality, free from all knots and sap, made of special heavy construction. It has 14% greater carrying capacity. Does not scale or pit. Is immune to frost and electrolysis. Is lighter and more easily installed. Sizes 1" and up—Lengths maximum 12 ft. Pressure to 172 lbs. Used for supply lines, penstocks, sewage, chemical lines, mines, fisheries and fume stocks.
A. WYCKOFF & SON CO., Office & Factory, 70 Home St., Elmira, N. Y.
1855 ORIGINATORS OF MACHINE-MADE WOOD PIPE 1934

FILCLOR
Chlorine and Ammonia
Control Apparatus
The Filclor Company
59th Street & Woodland Avenue, Philadelphia, Pa.

CLEARING HOUSE
TRANSITS FOR RENT
Guaranteed Rebuilt Transits and Levels available for **Rental** (with purchase option) —or for **Purchase**, with Easy Payment Plan. Write for descriptive list WWS-88 and Rental Schedule.
WARREN-KNIGHT CO.
Mfrs. Sterling Surveying Instruments
136 North 12th Street Philadelphia, Pa.

STREET, SEWER AND WATER CASTINGS

Made of wear-resisting chilled iron in various styles, sizes and weights.
Write for Catalog and Prices
SOUTH BEND FOUNDRY CO.
All Kinds of Gray Iron Castings SOUTH BEND, INDIANA

MECHANIC AND METER SUPERINTENDENT—Capable of supervising and organizing meter repair and test department. Factory trained expert, who has worked his way through the meter business to chief inspector. Also experienced in Diesel and gasoline engine operation and maintenance. Married, best of references. Address: "S. A. E.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—28, MARRIED. Experienced in design, construction, and operation of water purification and softening plants. Understands water works accounting. Desires position with water company. Willing to start at bottom if possibility for permanency and promotion exists. Best of references. Address R. M. L., % Water Works and Sewerage, 400 W. Madison Street, Chicago.

CIVIL ENGINEER — Age 43; married; graduate; experienced in design of large and small sanitary and storm-water sewers; flood prevention structures, investigations and reports, highway construction of all types. Address: No. 2017, Phila. Technical Service Com., 1317 Spruce Street, Phila., Pa.

SUPERINTENDENT OR MANAGER of water system. Twenty-five years' experience as manager and engineer in every phase of business administration—bond issues, rates, valuations, office management, system operation, with design and construction of pipe lines, dams, wells, pumps, filters, mains, meters, etc. Present position as PWA loan examiner handling water, sewage and power applications. Member technical societies. Will furnish ample recommendations. Address R. H. C., % Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

CIVIL ENGINEER—Age 44; married; 15 years' experience as designer on large sewage treatment works and collecting sewers; 7 years' surveying experience on highways and sewers. Address: No. 2122, Phila. Technical Service Com., 1317 Spruce Street, Phila., Pa.

WATER SUPPLY AND HYDRAULIC ENGINEER—45; married; graduate C. E.; 20 years' broad experience, including design and maintenance of water purification and softening plants, reservoirs, and distributing systems. Address: No. 45, Phila. Technical Service Com., 1317 Spruce Street, Phila., Pa.

SANITARY ENGINEER—Graduate engineer with 12 years' experience in sanitation and public health engineering. Former City Chemist, with experience in water and sewage works operation; for past several years in State and County health work. Desires operating or public health engineering position—location immaterial. Address R. E. C., care of Gillette Publishing Company, 420 Lexington Ave., New York City.

WATER WORKS ENGINEER-MANAGER —20 years' experience in design construction, operation and management. Available after July 15th. Address "A. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

REGISTERED CIVIL ENGINEER — 44; married; graduate; 24 years' experience; design of large sewerage system, pumping stations, treatment works and construction of machine shops and large dry dock. Address: No. 1700, Phila. Technical Service Com., 1317 Spruce Street, Phila., Pa.

CIVIL ENGINEER—B.C.E. Polytechnic Institute of Brooklyn '34, age 22, single. Desires work of any nature qualified for. Location immaterial. Available immediately. Address "I. A.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—33, married. A.B. Stanford Univ., Grad. study Univ. of Ill. Nine years' experience in design, construction and operation of various sewage treatment projects. Author of several papers on technical and research phases of sewage treatment. Registered Civil Engineer, Associate member Am. Soc. Civil Eng. Officer of local Sewage Works Ass'n. Desires position with municipality, manufacturer or consulting engineer, or as teacher. Available immediately. Location immaterial. References on request. Address T. R. H., % Water Works and Sewerage, 400 W. Madison St., Chicago.

CHEMICAL ENGINEER—M.S., age 26, married, 2 years indust., 3 years prof. chem. engr., 1 year chem. and bactr. consultation, wants job, plant or laboratory work. Reasonable salary with opportunity for advancement. Six weeks' notice required. Address Box 600, % Water Works and Sewerage, 400 W.

SIMPLEX

Simplex Indicating Recording Totalizing Meter Register

Venturi Type Meters
Effluent Controllers
Filtration Plant Gauges
Water Works Specialties

WRITE FOR BULLETINS

SIMPLEX VALVE & METER CO.
6743 Upland Street
Philadelphia, Pa.

"ISCO" Ferric Chloride

In the Filter Plant it is an effective and economical coagulant.

Ferric Chloride works fast—requires less mixing and settling time.

In the Sewage Plant it is an aid to rapid sludge drying. Applied to crude sewage it will increase settling tank efficiencies and reduce loadings on sprinkling filters and other secondary units.

Ferric Chloride treatment following sprinkling filters will produce a sparkling final effluent from humus tanks.

"ISCO" CHLORINATED LIME

For sterilization of water supplies or swimming pools, and for chlorination at sewage plants, provides a safe, convenient treatment with less total chlorine required.

"ISCO" SERVICE

We have a sanitary chemical engineering staff, experienced through wide contacts and successful installations. May they contribute their experience and information to your problem?

DISTRIBUTORS OF "CLIFF-CHAR" ACTIVATED CARBON

Write for full particulars

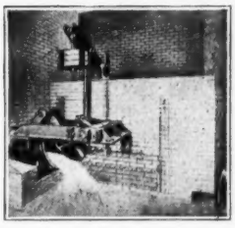
INNIS, SPEIDEN & CO.
INCORPORATED
117 LIBERTY STREET, NEW YORK.
Established 1816

Use P F T Equipment *for* Sewage, Water *and* Industrial Waste Treatment

Write for Latest Bulletins

PACIFIC FLUSH TANK COMPANY
Designers & Manufacturers of Sewerage and Sewage Treatment Equipment
4241 RAVENSWOOD AVE. CHICAGO, ILL.
EXCLUSIVELY SINCE 1893
136 LIBERTY STREET NEW YORK, N.Y.

INSURE DEPENDABLE CONTROL BY USING
McNULTY
TOGGLE-JOINT AUTOMATIC
SEWER REGULATORS

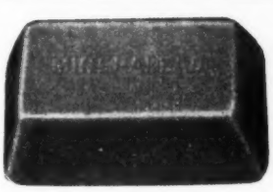


TYPE "C"

Embodying extra heavy and rugged construction, McNulty Regulators give unfailing service. They are continuously automatic and insure dependable control of any predetermined flow in cubic feet per second. Because they are of the Flap Gate type there is no chance of clogging or jamming.

Let our sewerage engineers cooperate with you in solving your problems. Write us today.

THE McNULTY ENGINEERING COMPANY
200 Old Colony Ave. So. Boston, Mass.



USE MINERALEAD
For Jointing Bell and Spigot Water Mains

Easy handling, ingot form—Impervious to moisture—Absolute uniformity—Easy melting—Rapid pouring—No caulking—Less initial leakage—Bell holes unnecessary—A saving in cost of material and labor.

Write for Catalog
THE ATLAS MINERAL PRODUCTS COMPANY
of Pennsylvania
MERTZTOWN PENNSYLVANIA
Established 1892
G-K Sewer Joint Compound

ROBERTS FILTER MANUFACTURING CO.
607 Columbia Ave., Darby, Penna.

Manufacturers of Pressure and Gravity Type Water Filters and Specialties for Water Purification and Sewage Treatment Plants.

We contract for complete installation of mechanical and hydraulic equipment in all forms of Water Filtration Plants, Sewage Disposal Plants and Pumping Stations.

Write us concerning your Sanitary Problems.

ADVERTISERS IN THIS ISSUE

A
Abrams Aerial Survey Corp. ... 46
Alvord, Burdick & Howson ... 46
Atlas Mineral Products Co., The ... 49

B
Baker, C. M. ... 46
Black & Veatch ... 46
Builders Iron Foundry ... 9
Burns & McDonnell ... 46

C
Caldwell Co., Geo. A ... 48
Carborundum Co., The ... 4
Cast Iron Pipe Research Asso., The ... 5
Chester Engrs., The J. N ... 46
Chicago Testing Laboratory, Inc ... 46
Cleveland, H. Burdett ... 46

D
Dixon, G. Gale ... 46

E
Economy Pumping Mach. Co ... 47
Edson Corporation, The ... 48

F
Filclor Company, The ... 48
Filtration Equipment Corp. ... Second Cover
Fowler, Charles Evan ... 46
Fuller & McClintock ... 46

G
Gillette Publishing Co ... 8-50
Great Western Electro-Chemical Co ... 45

H
Hellige, Inc. ... 47
Hill, Jr., Nicholas S ... 46
Hydraulic Development Corp ... 45

I
Industrial Chemical Sales Co., Inc ... 6
Innis, Speiden & Co ... 49
International Filter Co ... 47

K
Kimberly, A. Elliott ... 46
Knowles, Inc., Morris ... 46

L
LaMotte Chemical Products Co ... 48
Lock Joint Pipe Co ... 47
Lynchburg Foundry Co ... 9

M
Mathieson Alkali Works, The ... 7
McNulty Engineering Co., The ... 49
Metcalf & Eddy ... 46

O
Oliver United Filters, Inc ... Third Cover

P
Pacific Flush Tank Co ... 49
Phipps & Bird, Inc ... 47
Pirnie, Malcolm ... 46
Potter, Alexander ... 46
Powell, Sheppard T ... 46

R
Roberts Filter Mfg. Co ... 49
Rosing, Inc., Astrid S ... 46
Royer Foundry & Mach. Co ... 45

S
Simplex Valve & Meter Co ... 49
South Bend Foundry Co ... 48

T
Taylor Audit Co., P. H ... 46

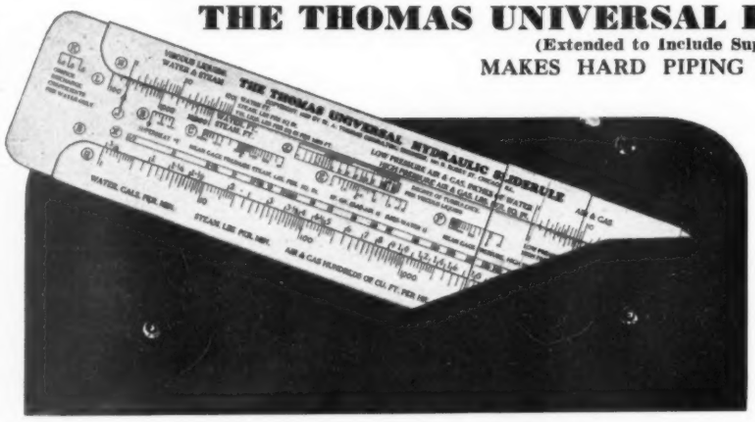
U
United States Pipe & Foundry Co ... 10

W
Wallace & Tiernan Co ... Back Cover
Whitman & Howard ... 46
Wilson, P. S ... 46
Wyckoff & Son, A ... 48

THE THOMAS UNIVERSAL HYDRAULIC SLIDERULE

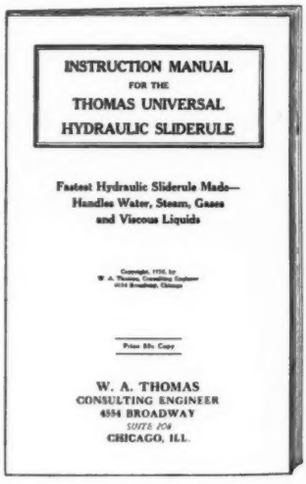
(Extended to Include Superheated Steam)

MAKES HARD PIPING PROBLEMS EASY



12-INCH SIZE

FOR ALL LIQUIDS AND GASES



Rapid! **Complete in Black Leather Case with Manual** ***Accurate!***

The only sliderule that computes the flow of any liquid or gas through pipes. Handles water, steam, superheated steam, high and low pressure air and gas, and viscous liquids through pipes, and water through orifices. Only one slide to operate, fast operating, gives discharge, friction loss of head, diameter of pipe, etc., quickly and in units familiar to the industry. An unusually complete manual of instructions accompanies each rule, fully works out every type of problem likely to be encountered, gives 42 examples, and much informative data, illustrated. Used and recommended by Crane Co. Engineers.

Durably made of heavy white celluloid, complete with reminder instructions printed on back, leather case and instruction manual.

PRICE, $2.50

GILLETTE PUBLISHING COMPANY,
400 West Madison Street,
Chicago, Illinois.

Please send on approval one Thomas Universal Hydraulic Sliderule and Instruction Manual. At the end of five days I will either forward my check for $2.50 or return them to you.

Name .....

Occupation .....

Street No. .....

City ..... State .....

W. W. & S. 8-34

EXPERIENCE

NOT EXPERIMENT

.....insist upon this in your specifications

Commercial scale experience is the most important item to be included in your specifications for continuous mechanical sludge dewaterers. You can and should insist upon it from the manufacturer of this equipment.

Oliver United's experience is based on the following record: over 20,000 sq. ft. of continuous, vacuum filter area already installed for dewatering sewage sludge; 42 separate units in daily operation; 4 more units, totalling 600 sq. ft., being installed or under contract. This is practical experience of the most valuable kind.

It is not difficult to manufacture a vacuum filter, but to make this filter dewater sewage sludges continuously and efficiently requires broad experience and knowledge.

In preparing plans for a modern sewage plant or for modernizing your present plant, keep these points well in mind: (1) Continuous mechanical dewatering of sewage sludge is desirable, practicable, and economical; and (2) Oliver United Engineers **are** experienced.

★ ★ ★ ★ ★

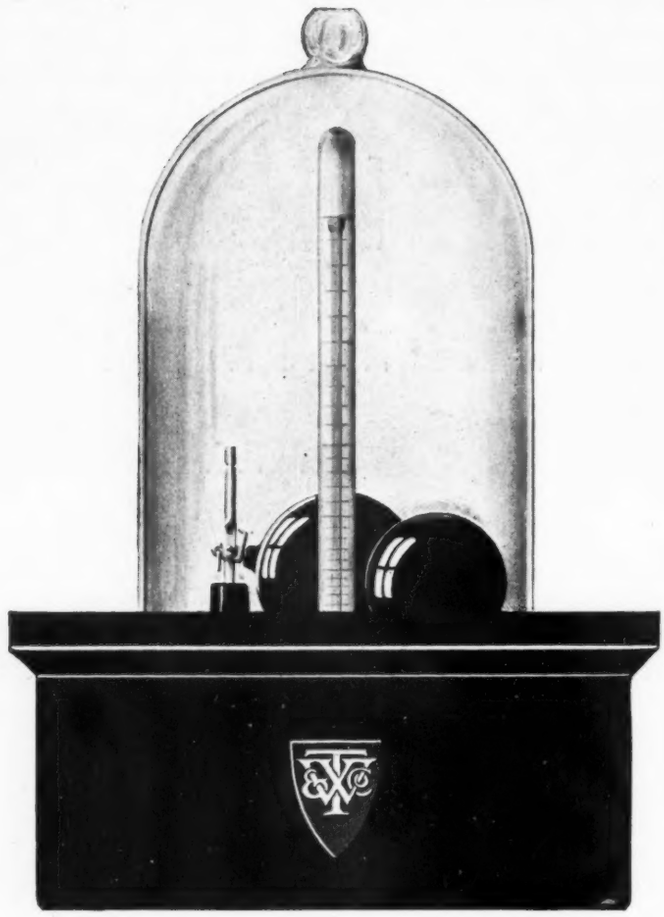
Within the past few months these four cities have adopted Oliver Continuous Mechanical Dewatering as the method for drying the sludges: Springfield, Ohio; Rockford, Michigan; Annapolis, Maryland; Oklahoma City, Oklahoma. At Rockford, waste from a tannery is to be combined with the city sludge.

OLIVER UNITED FILTERS INC.

New York
33 West 42nd St.

Chicago
221 N. LaSalle St.

San Francisco
351 California St.



DON'T PLAY HIDE AND SEEK WITH TROUBLE

It's the unseen, unknown trouble that eventually develops into a serious difficulty. That's just as true of chlorinators as it is of any other equipment. But—there is no need of your playing hide and seek with trouble in W&T Visible Control Vacuum Chlorinators because the working parts are under the glass bell jar—always in plain sight.

That's one reason why annual maintenance costs average less than 1%.

Technical Publication 38 describes visible control chlorinators in detail. Ask for a copy.

WALLACE & TIERNAN CO.

INCORPORATED

Manufacturers of Chlorine and Ammonia Control Apparatus

Newark, New Jersey — Branches in Principal Cities

Main Factory—Belleville, N. J.

"The Only Safe Water Is a Sterilized Water"

SA-50